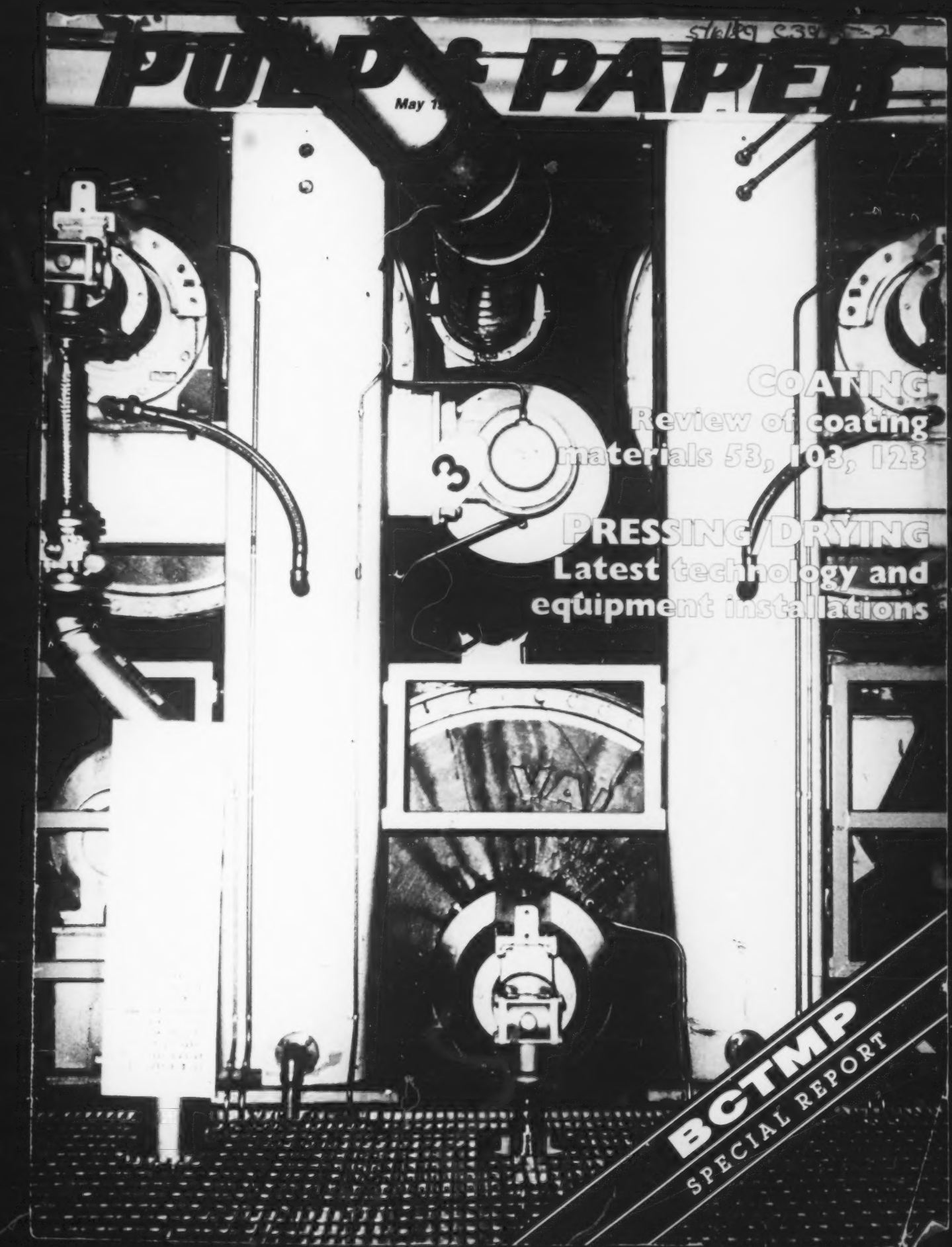
PULP & PAPER

May 1



COATING
Review of coating materials 53, 103, 123

PRESSING/DRYING
Latest technology and equipment installations

BCTMP
SPECIAL REPORT

Volume 63
Number 5

MAY

FOCUS: COATING

Hollow-sphere pigment 53
HSP technology improves sheet gloss, printability, and opacity retention, cuts use of more expensive pigments

Coated paper 90
Market is stable as customers digest inventories that were built up in anticipation of price hike

Kaolin clays 103
Widely varying properties of kaolin, such as brightness, are graded according to paper coating end uses

Mineral, chemical markets 123
Inorganic mineral, chemical markets achieve new heights in 1988 and are expected to remain strong in 1989

FOCUS: PAPERMAKING/ FORMING AND DRYING

Drying paper coatings 84
Historical examination focuses on development and application of air-floater, infrared-air equipment

Innovative felt run 114
Inland-Orange mill uses links press and dryer section with single felt, reduces draw and breaks; runability improves

Weyco ENP installation 121
Mill installs new press on corrugating medium machine using employee design team to improve performance

BCTMP SPECIAL REPORT

World of market BCTMP S1
20-page review focuses on recent, future bleached chemi-thermomechanical pulp growth worldwide

THE COVER

This issue focuses on pressing/drying and coating, Parts III and IV, respectively, of a special three-issue report on papermaking. **(Photo of paper machine dryer section courtesy of Valmet Paper Machinery, Charlotte, N.C.)**

OTHER FEATURES

PAPERMAKING

Clay vs $CaCO_3$ 55
A mix of kaolin clay and calcium carbonate can cut filler furnish costs in alkaline papermaking

FINISHING/CONVERTING

Dry-end steam showers 100
A new design of steam showers used on the paper machine dry end has improved finished sheet qualities

"Floating" roll transporter 138
Finnish converting plant uses air bearing transporter to move, handle paper rolls; worker strain is eased

CHEMICAL PULPING

U.S. liner market 134
Liner market should remain in balance with no major oversupply, but operating rates will dip in 1990

OCC trends 153
Consumption of recycled corrugated containers will increase in the U.S. as costs of virgin fiber rise

PROCESS AUTOMATION

Continuous control 143
Distributed control systems can dramatically boost output and improve pulp quality

MANAGEMENT

Reader salary survey 72
This issue contains a postage-paid questionnaire form that readers can fill out and mail in; results will be published in our September 1989 issue

Employee drug use 88
Despite current legislation, companies are still in the dark when it comes to setting up drug testing programs

IP's expansions 112
International Paper takes advantage of the profitability of expanding into world markets

PULP&PAPER

EDITORIAL STAFF

ATLANTA
Editor in Chief Ken L. Patrick
Technical Editor Jim Young
Projects Editor Kelly H. Ferguson

SAN FRANCISCO
Technical Editor Michael J. Ducey
Departments Editor Beverlee Davis

CHICAGO
Technical Editor Andy Harrison

NEW YORK
Consulting Editor John C.W. Evans

BRUSSELS
International Editors Peter Sutton
John Pearson
Hugh O'Brian

NEWS STAFF

SAN FRANCISCO
Executive News Editor Willard E. Mies
Senior News Editor Debra A. Garcia
News Editor Carl P. Espe
News Editor Rob Galin
News Editor Regina McGrath

NEW YORK
News Editor Noel DeKing

PRODUCTION STAFF

SAN FRANCISCO
Managing Editor Margaret L. Brown
Art Editor Nancy E. Bentley
Copy/Production Editor Marta L. Dils
Editorial Assistant Virginia C. Stefan

Atlanta: 2000 Powers Ferry Center, Suite 450 Marietta, Ga. 30067; (404) 952-1303; Fax (404) 933-0666
Chicago: 35 E. Wacker Drive, Chicago, Ill. 60601; (312) 372-6238; Fax (312) 372-3864
San Francisco: 500 Howard Street, San Francisco, Calif. 94105; (415) 397-1881; Telex 278273; Fax (415) 543-0256
New York: 370 Lexington Avenue, New York, N.Y. 10017; (212) 683-9294; Telex 220442; Fax (212) 725-0915
Brussels: Chaussée de Charleroi 123a, Boite 5, B-1060, Brussels, Belgium; Telex 846-24672

PUBLISHING HEADQUARTERS

SAN FRANCISCO
Publishing Director Leigh M. Freeman
Group Publisher Leonard E. Haas
Director of Production Andrew A. Mickus
Director of Circulation Wini D. Ragus
Ad Production Coordinator Gary A. Fong
Marketing Manager Paula J. Irons
Marketing Assistant Robin M. Connery
Editorial Secretary Logan B. Mumaw

Sales and business offices are listed on Advertisers' Index page

MILLER FREEMAN publications

Chairman of the Board ..... Clifford D. Jakes
President ..... Marshall W. Freeman
Vice President ..... Charles C. Baake
Vice President ..... Charles H. Benz
Vice President ..... Leigh M. Freeman
Vice President ..... Leonard E. Haas
Vice President ..... Thomas L. Kemp
Vice President ..... Wini D. Ragus
Chief Financial Officer ..... Stephen A. Daniels
Treasurer ..... Miller Freeman III
Assistant Treasurer ..... Douglas M. Denny

MAY

COLUMNS

From the Editors 7
by Andy Harrison
Where do we draw the line on ethics?

Quality Report 159
by Lars Ingman
Furnish optimization . . . making it right

Career Development 161
by Roberta Bhasin
How to drive everyone crazy

Maintenance Management 173
by Christer Idhammer
More or less in Swedish mills

Comment 218
by Irene W. Meister
Bringing down trade barriers

DEPARTMENTS

Conference Calendar 41
News of People 163
Product Showcase 177
New Products 177
Product Review 187
Literature 189
Bookshelf 193
Supplier News 195

SERVICES

Reader Service Review 166
Reader Service Index 168
Reader Service Card 169
Professional Service Directory 198
Classified Advertising 200
Advertisers Index 216

NEWS

Month in Statistics 9
U.S. paper and paperboard production data for February

Market Report 11
Newsprint producers delay hike
Forms bond not to increase yet
Boise abandons Apr. 1 No. 5 increase

Grade Profile 13
Coated groundwood: New capacity, inventory reductions balance demand after buying sprees

NEWS SCAN

Repap acquires Manfor 23
Tembec to sell share of machine 23
P&W may build kraft pulp mill 25
Asitka Resource tries to back mill 25
Menasha to upgrade at Otsego 25
U.S. Paper Mills to install machine 25
U.S. newsprint consumption falls 27
James River rebuilds machine 29

SBS market remains tight 29
Nocopi banking on lawsuit 29
EPA issues proposed dioxin limits 31
Canadian mills violate permits 33
Mills to supply dioxin-free board 33
Willamette seeks patent 35
First-year lump sums the norm 37

International News 39
Metsä-Serla to buy MoDo mills
Tasmania looks for investors
James River expands in Europe
Jari restarts damaged mill
Europe's output up 6.9% in 1988
Companies increase sales to U.S.S.R.
Japan's newsprint demand rises
UK Paper increases capacity

PULP & PAPER (ISSN 0033-4081), with which is combined *Paper Mill News*, *Paper Trade Journal* and *Pacific Pulp & Paper*, is published monthly except November when semimonthly by MILLER FREEMAN PUBLICATIONS, 500 Howard St., San Francisco, Calif. 94105. Second class postage paid at San Francisco and at additional mailing office. POSTMASTER: Please send addresses changes to PULP & PAPER, 500 Howard St., San Francisco, Calif. 94105.

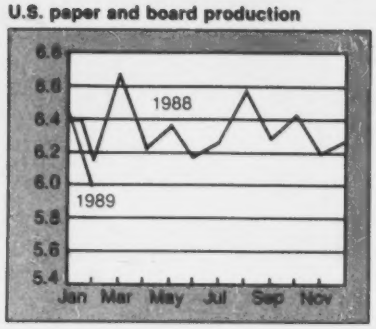
© Copyright 1988 by Miller Freeman Publications Inc. All rights reserved.

Subscriptions & Address Change: Sent without charge in the U.S.A. & Canada (upon written request) to individuals in pulp, paper, and board manufacturing firms and paper converting firms. To all others there is a subscription charge of $70.00 a year in the U.S. All subscriptions to other countries: US$90.00 a year, except Europe and Mediterranean, US$100.00 (air service included). Single copy, US$7.00, except Buyers Guide, US$35.00. 16mm microfilm, 35mm microfilm, 105mm microfiche, and article and issue photocopies are available from University Microfilms International, 300 N. Zeeb Rd., Ann Arbor, Mich. 48016; (313) 761-4700. Requests, subscription orders, and address changes must show name and position or job of individual, the name and location of mill, plant or office where employed, and the exact business or product produced at this location. Send subscription correspondence to: Circulation Department, PULP & PAPER, 500 Howard St., San Francisco, Calif. 94105. For address change, include label from recent issue.

ABP

BPA

U.S. paper and board production



U.S. production of paper and paperboard totaled 6.0 million tons in February, down 3.7% from a year earlier, according to the American Paper Institute. The decline was not really that sharp, however, because February 1988 had an extra day's worth of production due to Leap Year. On a seasonally adjusted basis, paper and paperboard production is holding its own with last year's record numbers. The adjusted annual rate for paper in February was 38.3 million tpy, an increase of 0.4% over last year, while paperboard inched up 0.2% to 38.8 million tpy.

Among major grades, uncoated groundwood paper posted the largest gains, reflecting strong demand from commercial printers and publishers of catalogs and directories. Production of containerboard for domestic use dipped 0.9% in February, but corrugated box shipments were up 2.2%, after adjusting for the extra day last year.

Canadian newsprint shipments totaled 731,000 metric tons in February, down 6.5% from a year earlier, but woodpulp shipments rose 3.4%, to 663,000 tons. Canada's exports to the U.S. rose sharply in January, led by a 25.4% jump in newsprint and a 40.6% increase in pulp. ■

	Latest month	(000 short tons)	% change from year ago	Annualized year-to-date (000 short tons)	% change from year ago
PAPER & PAPERBOARD PRODUCTION[1]					
Newsprint	Feb.	445	-7.1	5,713	-2.6
Uncoated groundwood (s)	Feb.	131	1.6	1,673	8.6
Coated paper (s)	Feb.	551	-7.1	7,109	-3.8
Uncoated free-sheet (s)	Feb.	899	-2.2	11,185	0.1
Other printing/writing	Feb.	119	-6.3	1,462	0.5
Total packaging and other paper (s)	Feb.	408	-6.2	5,175	-1.9
Tissue	Feb.	435	-0.5	5,403	1.3
Total paper	**Feb.**	**2,986**	**-4.3**	**37,712**	**-0.9**
Unbleached kraft paperboard	Feb.	1,522	-2.9	19,049	-1.2
Semichemical medium	Feb.	437	-3.7	5,592	-1.1
Bleached paperboard	Feb.	338	-6.1	4,293	-3.4
Recycled paperboard	Feb.	699	-2.5	8,732	-0.7
Total paperboard	**Feb.**	**2,996**	**-3.3**	**37,666**	**-1.2**
Total U.S. paper and paperboard output	**Feb.**	**5,983**	**-3.7**	**75,378**	**-1.1**
PULP, WASTEPAPER & FIBER[2]					
Total U.S. woodpulp production	Jan.	5,471	3.7	65,653	3.2
Market pulp production	Jan.	785	8.7	9,424	8.1
Wastepaper consumption at paper/board mills	Jan.	1,573	1.2	18,878	1.2
Pulpwood consumption (cords)	Jan.	8,358	1.6	100,296	1.6
CONVERTED PRODUCTS STATISTICS[3]					
Corrugated box shipments (billion ft²)	Feb.	24.086	-2.7	50.528[6]	1.9
Containerboard inventories at U.S. box plants and mills	Feb. 1	2,719	2.1		
INTERNATIONAL TRADE[4]					
U.S. paper imports (including products)	Jan.	1,297	25.4	15,565	25.5
Imports of Canadian newsprint	Jan.	893	26.0	10,713[6]	26.0
U.S. paper exports (including products)	Jan.	439	-10.8	5,263	11.5
Exports of unbleached kraft linerboard	Jan.	160	6.7	1,918	4.5
Exports of woodpulp	Jan.	457	16.9	5,487	17.1
Norscan pulp inventories[4]	Feb. 28	890	-1.7		
Norscan pulp operating rates[4]	Feb.	98%	100%	99%	99%
CANADIAN STATISTICS[5]					
Total newsprint shipments	Feb.	731	-6.5	1,494[6]	-0.3
Operating rates	Feb.	99%	101%	99%	100%
Inventories held by U.S. consumers	Feb. 28	1,472	-0.1		
Other paper/board shipments	Feb.	529	-0.9	1,074	1.4
Woodpulp shipments (export only)	Feb.	663	3.4	1,274	1.6
Operating rates	Feb.	95%	96%	96%	97%

1. American Paper Institute. 2. API, Bureau of Census, American Pulpwood Assn. 3. Fibre Box Assn., Paperboard Packaging Council. 4. North American/Scandinavian paper-grade market pulp. 5. Canadian Pulp & Paper Assn. 6. Not annualized. (s) = Shipments.

Coated groundwood: New capacity, inventory reductions balance demand after buying sprees

Grade structure: Coated groundwood papers contain 10% or more mechanical pulp, with chemical pulp and fillers making up the balance. About 85% of coated groundwood production is No. 5. The rest is No. 4 grade, which has higher brightness and usually heavier basis weights (a small portion of coated groundwood is classified as No. 3). No. 5, therefore, is valued not only for its lighter basis weights but also for its runability.

Coated groundwood paper usually runs in the 32-lb to 50-lb basis weight range (25 × 38 in. in reams of 500 sheets). Some 30-lb and 70-lb papers also are made. Coating weight on lightweight coated (LWC) paper may be about 30% of total sheet weight.

The strongest competitor to coated groundwood is uncoated groundwood, particularly supercalendered. Competition occurs in many end uses, including advertising inserts and flyers, consumer and trade magazines, Sunday newspaper supplements, catalogs, directories and other books, direct mail, and other commercial printing.

Production/capacity: U.S. mills produced 10% more coated groundwood paper in 1988 than they did in 1987, a year in which shipments rose 9%. This continues the upward growth trend that began in 1984 and 1985. Commercial printing continues to be the fastest-growing end use that includes such products as advertising inserts and flyers. The largest end-use market is the snoozing magazine and periodical sector, which has remained relatively stagnant.

No new coated groundwood paper machines were brought online in 1988, but machines brought online in late 1986 reached their peak production levels. Some new tonnage will be added this year: Blandin Paper Co., a unit of Fletcher Challenge Canada Ltd., will start up its 250,000-tpy coated groundwood machine in Grand Rapids, Minn., in the second half of the year, as will Repap Enterprises Inc., with its 230,000-tpy machine in New Castle, N.B. (Canada currently has an estimated 400,000-short-tpy of coated groundwood paper capacity). The American Paper Institute said that U.S. capacity is expected to advance just under 2.3% in 1989.

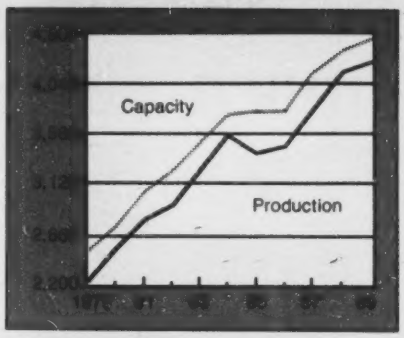
Blandin is likely to go ahead with an additional machine at Grand Rapids, while Repap may install a machine at Prince Rupert, B.C. Boise Cascade Corp. is rebuilding two machines at Rumford, Maine, though the machine now making No. 5 paper will be switched to Nos. 3 and 4 free-sheet. Pentair Inc. is upgrading its publication papers mill in Niagara, Wis., adding 40% more coated groundwood capacity, which will bring the mill rating to 320,000 tpy. Consolidated Papers Inc. is rebuilding No. 64 machine at Wisconsin River (Whiting), Wis. Weyerhaeuser Paper Co. reportedly is still considering a second LWC machine at Columbus, Miss.

Overcapacity in Europe and the desire to keep market share have kept U.S. imports of coated groundwood paper fairly level.

Outlook: Rising prices in 1987 and 1988 encouraged inventory building, especially by merchants and commercial printers, creating tight markets for most of the year. But demand started to slacken toward the end of 1988 and into 1989, so much so that an expected first- or second-quarter price increase was effectively postponed until the beginning of the third quarter. Even though some analysts still call for a recession in second-half 1989 or the beginning of 1990, most insist the paper industry will do well again in 1989. Magazines are perhaps one of the most vulnerable areas.

Prices: Strong demand and tight markets caused prices for coated groundwood papers to rise in 1988 (as they did in 1987), though by the end of the year and into early 1989 some minor discounting was reported because demand is expected to remain fairly constant and new capacity to come only moderately, list prices probably will remain at current mid-year levels (if prices are raised in July), at least through the end of 1989.

Historical pricing trends ($/short ton, year-end, except 1988, which is first quarter) are: for No. 5, 34-lb roto paper, 1981, $760; 1982, $760; 1983, $782; 1984, $890; 1985, $931; 1986, $860; $1987, 890; 1988, $990; 1999, $990.



	1987	1988	1989e
Production[1]	3,782	4,160	4,335
Capacity[2]	4,136	4,376	4,478
Utilization rate	91.4	95.1	96.8
Imports	500e	591e	577
Exports	39	46	53
Apparent U.S. consumption	4,243	4,705	4,859
lb/capita	34.79	38.23	39.15
GNP ratio	2.21	2.36	2.73

e = Estimate.
1. *P&P* estimate.
2. American Paper Institute.
3. 1,000 tons/billion $ real GNP.

(000 tpy)

	Annual capacity	Market share (%)
1. Champion	689[1]	14.3
2. International Paper	645[2]	13.4
3. Consolidated	600[2]	12.4
4. Repap[3]	450	9.3
5. Bowater	340	7.0
6. Blandin	311	6.4
7. Mead	300	6.2
8. Boise	285	5.9
9. James River	234	4.8
10. Pentair[4]	220	4.6

Market share of top five companies: **56.4%**

Market share of top ten companies: **84.3%**

Total North American capacity (1989): **4.828e million short tons** (U.S.: 4.478; Canada: 0.390)

1. 1988 production.
2. *P&P* estimate.
3. Includes U.S. and Canada.
4. Niagara of Wisconsin.

ACQUISITIONS/MERGERS

Repap buys Manfor, will convert to kraft pulp

Repap Enterprises Inc. said that it will buy Manfor Ltd. from the Manitoba government for C$132 million. The company will convert the existing unbleached kraft pulp and paper mill to bleached kraft pulp and then build a second line that will give the complex the capacity to produce a total of 1,700 tpd of bleached kraft pulp. The terms of the transaction call for Repap to pay the Manitoba government C$40 million in cash in addition to C$92 million in preferred Repap shares that can be redeemed at the company's option.

Repap chairman George S. Petty has been working since 1980 on a plan to buy Manfor.

Repap plans to invest C$200 million starting this spring to convert the existing pulp mill from 400 tpd of unbleached kraft to 500 tpd of bleached softwood kraft. The provincial government will provide an incentive for this phase of the project by purchasing $30 million in preferred shares. When this first phase is completed in about 18 months, the 286-in.-wide kraft paper machine will be converted to a pulp dryer. In the meantime, the company will continue to produce kraft paper.

Before the end of 1990, work will begin on the second phase of the mill upgrade. Repap is planning to invest an additional C$800 million to construct a new 1,200-tpd pulp mill at The Pas, Man. When construction of the new pulp mill is completed, Repap will convert the older, smaller mill from softwood to hardwood pulp. Part of the pulp will be used at Repap's Wisconsin coated paper complex, which has a capacity of 450,000 tpy.

The Manitoba government is committed to providing loan guarantees of C$150 million for the new mill. In addition, Repap will gain harvesting rights to about 108,000 km² (42,000 square miles) of forest lands containing about 3.2 million m³ (1.4 million cords) of timber. Repap will construct a new woodchipping facility as well as a forest-harvesting administration center in Swan River, Man. To make Repap's timber harvesting task more economical, the province will invest C$90 million to upgrade highways in northern Manitoba.

Troubled history. The provincial government has owned the mostly money-losing kraft paper and lumber concern in The Pas since Churchill Forest Industries, a predecessor company, went into receivership in 1971. Succeeding governments have been trying to sell Manfor to the private sector ever since.

The Conservative government gave a nominal value of $1 to Manfor and wrote off its investment in the company last year. Including the loss on Churchill and a debt conversion in 1983, the province has pumped more than C$250 million into the mill. A cabinet committee was formed last fall to hold discussions with companies interested in acquiring the mill. These included Weyerhaeuser Canada Ltd., Daishowa Paper Manufacturing Co. Ltd., Pentair Inc., and Repap.

Repap chairman George Petty said the company had been working on a deal to acquire Manfor since 1980. Repap's strategic plan is to change Manfor's product mix, Petty told the Toronto *Globe & Mail*. "Our fundamental assessment is that it's inappropriate to be making kraft paper out of high-quality northern spruce. We're going to upgrade the entire project to bleached chemical pulp and later add paper machines," he said.

Manfor is Canada's largest independent producer of kraft paper and the biggest exporter of unbleached kraft paper to the U.S. Using a Flakt air dryer called Super Performance Kraft (SPK), Manfor produces a high-quality paper that is used in multiwall shipping sacks. Exports to the U.S. reached nearly 80,000 tons in 1988. The pulp and paper mill has capacity to produce 140,000 tpy of paper, and an adjoining sawmill has annual capacity of 100 metric bd ft.

New job creation. Petty said Repap will create 350 to 400 new permanent jobs over the two phases of the project, which could take until 1994 to fully complete. Besides the direct employment benefits and the $1 billion in direct investment, Repap will also spend $20 million on a training program for Manfor's 850 employees.

Petty added that Manfor should be making a contribution to Repap's profits by 1990 since it has a positive cash flow. Manfor posted a modest profit of C$3.3 million in 1987, after many consecutive years of losses.

"The most significant impact of the sale is job creation. These new jobs, coupled with the massive spin-off benefits, will put northern Manitoba on a solid economic footing for the future," said Manitoba premier Gary Filmon. ■

World woodpulp requirements (millions of metric tons).

	1988	2000	Change
Bleached softwood kraft	30	43	+13
Bleached hardwood kraft	28	45	+17
Mechanical	41	57	+16
Unbleached	35	44	+ 9
Other	10	10	—
Total	**144**	**199**	**+55**

Source: Repap Enterprises Inc.

Tembec to sell 50% share of new machine to Smurfit

Jefferson Smurfit Corp. will acquire a 50% share of Tembec Inc.'s new 140,000-metric-tpy bleached paperboard mill, which Tembec is building adjacent to its existing sulfite pulp mill and Temcell bleached chemithermomechanical pulp (BCTMP) mill in Temiscaming, Que. Under the proposed agreement, Smurfit will pay about C$30 million for an undisclosed number of partnership units in Temboard & Co. Ltd. Partnership, the company Tembec formed to finance and construct the new mill.

After the units are converted into common shares and other investors are bought out, Smurfit and Tembec will each hold 50% of Temboard's equity. Other investors in the limited partnership include the Belkin family of Vancouver, B.C.; Lummus Canada, general contractor for the new mill; and Rexfor, the Quebec

the headbox and fourdrinier section, from another company, but it will install new dryers, winders, and other equipment. The machine will mainly produce lightweight core stock for the tissue and toweling industry. "The strategy is to be a viable force in the lightweight core stock industry," said Robert Cloud, U.S. Paper's executive vice president and CEO.

U.S. Paper also produces core stock at its DePere, Wis., mill. Plans call for the new fourdrinier machine to produce brown grades of lightweight core stock, which will enable the machine in DePere to run white and specialty core stock grades. "This will help eliminate the costly changeover and washup time needed to go from grade to grade," said Cloud. Last year, the company produced about 55,000 tons of lightweight paperboard at Menasha and 32,000 tons of heavier-grade paperboard at DePere and reported sales of about $30 million. In January, the company acquired Ideal Paper Tubes & Cores, a small converting firm in St. Paul, Minn. ■

NEWSPRINT

U.S. newsprint consumption wanes due to shortage

Confirming its own previous prognostication, a report issued by the American Newspaper Publishers Assn. recently indicated that newsprint consumption began to decline in 1988 due to tight markets in 1987 and subsequent efforts by newspapers to reduce orders as their newsprint costs rose and their advertising revenues fell.

The December 1988 report, "The Growth and Outlook for U.S. Newspapers and Newsprint Consumption," was written for ANPA by Jon G. Udell. Citing various trends during the past ten years and projecting out to 1995, Dr. Udell uses as one of his bases the conjecture that newspapers would reduce newsprint usage in the event of rising costs resulting from tight newsprint supplies.

This emerging trend is a turnaround from the phenomenal growth rate of the past decade. From 1976 to 1987, U.S. newsprint consumption expanded 33.6% (on a 30-lb basis weight) to 12.395 million metric tons. But in 1988, the growth rate came almost to a halt—slowing in the second quarter to an increase of less than 1% over the prior year.

Dr. Udell attributes this sluggish demand to at least two key factors: a slump in advertising lineage among some major newspapers and newsprint conservation efforts stimulated by the rising cost of newsprint. These, in turn, were sparked by modest consumer spending, increased newspaper advertising rates, retail industry mergers, and reduced financial aids from institutions still recovering from the Oct. 19, 1987, stock market setback.

Another somnolent year. Newsprint consumption in the U.S. in 1989 is expected to be virtually flat from 1988 due to increasing possibilities of a recession approaching later in the year—especially if interest rates continue to rise. Even if no recession occurs, notes Dr. Udell, the economy is likely to be sluggish, with reported tonnage expected to be up only slightly to 12.4 to 12.5 million tons (on a 30-lb basis weight). In the event of a recession, consumption would decline below 1987's level.

ANPA's trend projection of U.S. newsprint consumption in 1995 is 14.5 million tons, assuming a period of severe economic stress in these years but at least a 2.5% average annual growth in the U.S. economy. If the U.S. achieves a 3% or higher average annual rate of economic expansion in this period, demand would exceed 15 million tons by 1995.

The dynamics of the newspaper and newsprint industries could reduce this rate of growth, however. For example, notes Dr. Udell, if newsprint conservation measures initiated during 1988 are sustained, it could change this figure by about 100,000 tons or more.

Looking back at the past decade, Dr. Udell notes various trends. Regional growth in newsprint consumption has been most significant in the U.S. South and West, where it has increased 37% and 34% respectively (see table). During this time, Northeast newsprint usage was up 27%, but the north central region was up just 2%. Growth rates during 1977-87 were higher in cities with populations of less than 100,000 than in large cities with populations of over 1 million—38% vs 9%. Sunday newspapers' circulation was up by 6.4 million during this time, while daily circulation grew just 0.4 million.

Preprint growth still dynamic. The amount of preprint tonnage included in daily newspapers is not known. However, Dr. Udell estimates that in 1987, insert tonnage on all grades of paper—excluding coupons and catalogs—totaled an estimated 2.147 million tons. Of this amount, almost 800,000 tons of inserts were printed on newsprint. By 1992, the report indicates, newsprint usage by producers of preprinted inserts is forecast to rise to 905,000 tons, with an average annual growth rate of 2.6%, while tonnage of all inserts is predicted to grow at least 5%/year in that time.

U.S. newsprint producers have increased their supply of newsprint to daily newspapers by 28.3% during the last ten years. Tonnage originating in Canada rose 16.4%, resulting in U.S. producers' share of the domestic market increasing to 42.1% in 1987 from 40.9% in 1977 while Canada's share declined to 55.1% from 59.1%. Offshore suppliers accounted for almost none of the U.S. market in 1977 but for 2.9% by 1987. ■

Historical trends in newsprint consumption by U.S. daily newspapers in four major regions, 1977-87 (000 metric tons).

Region	1977 consumption	1987 consumption	Tons change	% change
Northeast	1,803	2,294	491	27.2%
North central	1,848	1,883	35	1.9
South	2,043	2,790	747	36.6
West	1,495	2,009	514	34.4
Total consumption by U.S. dailies	**7,189,672**	**8,976,598**	**1,786,926**	**24.9**
Total U.S. consumption by all users	**9,280,000**	**12,395,000**	**3,115,000**	**33.6**

Source: Daily newspapers reporting to the American Newspaper Publishers Assn.

COATED PAPER MARKETS STABILIZE AS CUSTOMERS DIGEST INVENTORIES

Printers and merchants built stocks anticipating price boost, but demand has calmed; mills are pushing next hike into July

By ROB GALIN, News Editor

Markets for coated papers are expected to remain in balance for the next two or three years, with capacity and production essentially in symmetry with demand, according to various paper industry sources and analysts. However, prices for both coated groundwood and coated free-sheet are expected to rise only once more this year, possibly in July.

The future for coated paper really holds no surprises for papermakers or end users. Topping the list of opportunities for coated groundwood are advertising inserts and flyers, catalogs, other commercial printing, and, perhaps, magazines, though the latter essentially will be a no-growth area. Coated free-sheet producers can look to promotional printing and annual reports for continued strong demand.

Mills had another good year in 1988, with most companies reporting record profits from all sectors. Producers shipped 7.5% more coated paper in 1988 than in 1987, resulting in a total of almost 7.4 million tons shipped. That compares with 5.0% higher shipments for all printing and writing grades in 1988.

This year started off much more slowly, with coated paper shipments in January dropping 1.6% from January 1988, according to the American Paper Institute. For full-year 1988, new orders of just over 7.4 million tons posted a gain of 5.0% over the previous year, but, here again, January 1989 posted a loss of 7.1% compared with the same month a year earlier.

One mill source said the beginning of the year was "sloppy" as a result of inventory reduction, perhaps from overbuying in 1988 in relation to actual price increases and feared price increases. However, the rest of the year should see an upturn as demand from catalog publishers comes on strong in the third quarter, possibly helping support a price increase.

Industry executives and analysts expect utilization to remain well above 90%, usually between 93% and 95%, through 1998, though William Wigder of First Boston Corp. is projecting a 96% operating rate for coated paper mills in 1989. That represents production of about 7.87 million tons, a 6.2% increase from 1988. Martin Hydell, vice president-marketing for fine papers at Mead Corp. said he is projecting good operating rates through the end of 1989 if the economy stays healthy. However, 1990 could prove to have softer markets, he said.

Offshore coated paper producers were able to take advantage of market opportunities in the U.S. last year. The U.S. Dept. of Commerce reported that imports of coated papers in all of 1988 climbed 17.0% above 1987 levels, to 788,865 tons. Discounting by offshore mills may have boosted U.S. purchases of foreign paper. In contrast, U.S. mills shipped 97,464 tons, or 3% less, of coated paper outside the country last year.

CONSUMPTION FORECAST. If analysts are correct, consumption of coated paper grades may rise 4.0% in 1989 and 4.8% in 1990. Apparent U.S. use of coated groundwood papers is to rise from an estimated 4.7 million tons in 1988 to almost 4.8 million tons this year, with a 3% increase in 1990, according to Merrill Lynch analyst Evadna Lynn.

Lynn expects that utilization of coated free-sheet grades will increase 3.1% to just over 3.5 million tons in 1989 from last year. By the end of 1990, consumption may hit almost 3.8 million tons. Wigder forecasts 6.0% average annual growth in coated free-sheet production and 6.1% growth in capacity.

Overall coated paper demand probably will continue to grow somewhat above real GNP in the next few years. API said that U.S. coated groundwood capacity rose about 5.8% to nearly 4.4 million tons in 1988, after an 8.8% increase in 1987.

Forecasts made in May 1988 by the European Paper Institute say that European operating rates in the next four years will remain under 80%. In fact, EPI estimates put excess coated groundwood tonnage at about 1.2 million metric tons in 1990, 1991, and 1992. Even this year, members of EPI may utilize mill capacity at only 79.7%, leaving 941,000 excess tons available.

Additional competition will come from the increasing capacity of high-quality supercalendered (SC) paper, such as Web-Sized Offset Paper (WSOP) from Abitibi-Price Inc.'s Kenogami, Que., mill and premium supercal-

endered (SC-A) paper from Lake Superior Paper Industries' mill in Duluth, Minn. Here again, Europe is expected to have about 400,000 metric tons more than demand in the 1989-92 period, with SC operating rates holding at the 87% to 88% range.

The slower market is also reflected by a decline in new orders and a reduction of backlogs. Extremely strong growth in 1988 exaggerates the picture somewhat, but the market definitely has slowed.

Also contributing to slower U.S. shipments this year and next is the continued rise in imports, which are expected to reach 850,000 tons this year and 890,000 tons in 1990. Imports are expected to reach nearly 1 million tons in 1991.

PRICES. The slight softening in demand caused by inventory "workdowns" prompted mills to put off a 1989 price increase until at least July. A recession could affect paper purchases, especially since advertisers cut promotional budgets when times are tough. If this happens, deep discounting could occur, and mills may even be forced to roll back the mid-year hike.

Prices for coated papers have not risen as often as other printing/writing grade sectors. Wigder expects coated free-sheet prices to rise 5% this year, but coated groundwood could fall 6%. However, the continuing rise in pulp prices almost guarantees paper price hikes, a mill source said. Within the various end-use sectors, commercial printing is expected to remain the strongest growth area.

Catalog markets seem to be doing well, despite increases in postal rates and paper prices, said Maxwell Sroge, a catalog industry consultant for Marke/Sroge Communications. "I think it's fairly strong right across the board," Sroge said. "I'd say the great strength is in the mid-market," which represents households with incomes of $30,000 to $50,000. Since paper prices and availability have stabilized, the threat to catalog publishers comes primarily from the U.S. Postal Service and Congress. USPS is considering another rate hike. In addition, tests indicate that 7% to 10% of catalogs mailed through the Postal Service are not delivered. To help beat the postal increases, catalog publishers are looking for high-quality, lightweight papers, Sroge said.

TABLE 1: **New North American coated paper capacity through 1991.**

Company, U.S.	Location	Annual short tons	Grade	Startup
Westvaco Corp.[1]	Luke, Md.	150,000	CGWD/CF	1984-86
Fraser Paper Ltd.	Madawaska, Maine	n.a.	CGWD	1987-89
Repap Enterprises Corp. Inc.[2]	Kimberly, Wis.	205,000	CF	1988
Blandin Paper Co.	Grand Rapids, Minn.	254,000	CGWD	1989
Potlatch Corp.[3]	Cloquet, Minn.	100,000e	CF	1989
Champion International[4]	Bucksport, Maine	n.a.	CGWD	1989
Pentair Inc.	Niagara, Wis.	90,000e	CGWD	1989-90
Champion International	Quinnesec, Mich.	385,000	CF	1990
Consolidated Papers Inc.	Wisconsin River, Wis.	n.a.	CGWD	n.a.
P.M. Glatfelter Co.[5]	Spring Grove, Pa.	16,500	CF	1990
S.D. Warren Co.	Skowhegan, Maine	215,000	CF	1990
S.D. Warren Co.	Muskegon, Mich.	45,000e	CF	1990
Westvaco Corp.[6]	Wickliffe, Ky.	n.a.	CF	1990
Boise Cascade Corp.	Rumford, Maine	46,000	CGWD/CF	1990-91
Simpson Paper Co.	Pasadena, Texas	55,000 to 60,000e	CF	1991
Blandin Paper Co.[7]	Grand Rapids, Minn.	250,000	CGWD	n.a.
Weyerhaeuser Paper Co.	Columbus, Miss.	n.a.	Under study	n.a.
Champion International	Courtland, Ala.	n.a.	CF	1990-93

Company, Canada	Location	Annual metric tons	Grade	Startup
Repap Enterprises Corp. Inc.	Newcastle, N.B.	180,000	CWD	1990
Repap Enterprises Corp. Inc.	Prince Rupert, Sask.	100,000e	CWD	n.a.
Island Paper Mills Co.	New Westminster, B.C.	75,000	CF	1990

e = *P&P* estimate.
CGWD = Coated groundwood.
CF = Coated free-sheet.
Sources: *Pulp & Paper Week*, *Pulp & Paper Project Report*, American Paper Institute, Canadian Pulp & Paper Association
1. Incremental additions.
2. 100,000 tpy net.
3. Conversion from uncoated to coated paper.
4. No. 4 machine speed increasing from 2,800 fpm to 3,500 fpm.
5. Reducing uncoated free-sheet capacity by 15,000 tpy.
6. Installation of off-machine coater for 550-tpd uncoated free-sheet mill. Will continue to produce uncoated papers as well as coated.
7. Awaiting final approval.

The Direct Marketing Assn. says that demand for catalogs is increasing significantly. Slightly more than 51% of the U.S. population (87.7 million Americans) shops by mail, a 15% increase from 1985, according to Simmons Market Research. This helped spur catalog production, which increased by 18% in 1986, representing 11.8 billion pieces from about 6,500 publishers.

Analysts suspect that demand for coated papers for catalogs could reach over 2 million tons by 1990. Mead forecasts catalog growth of 7.0% through 1992, accounting for 23% coated groundwood and 31% coated free-sheet paper manufactured.

Boise Cascade Corp. announced a price increase on coated No. 5 papers but withdrew it when no other mills went along. The list price for 40-lb No. 5 remains at $880/ton, with some discounting reported.

Price hikes of $60/ton for coated free-sheet grades announced by Consolidated Papers Inc. and other mills apparently have been accepted. Demand for higher-quality grades, Nos. 1 and 2, is reported to be strong.

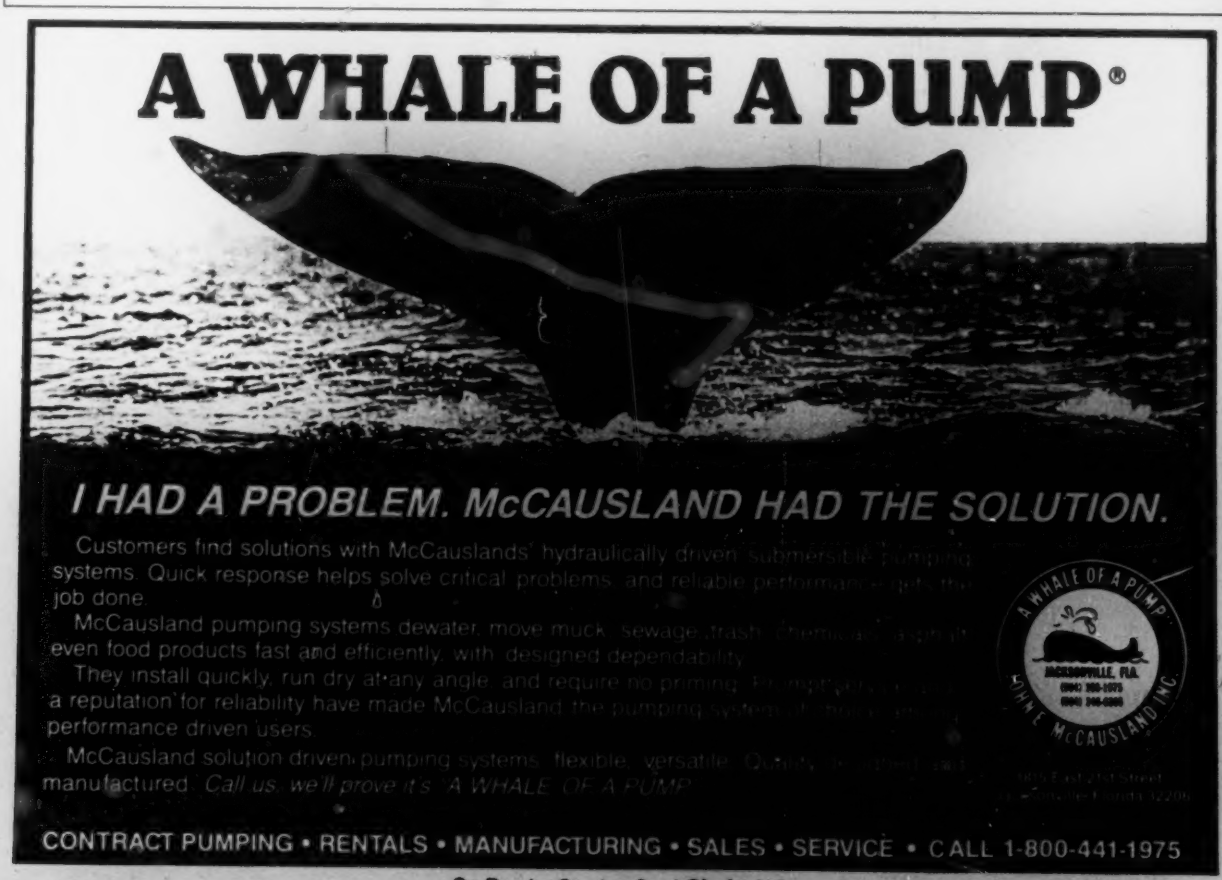
MAGAZINES "OK." Magazines did better in 1988 than expected, but gains were still relatively small, with only a 2.4% increase in the number of ad pages compared with 1987, according to the Magazine Publishers Assn. A potential advertising rate increase could create relatively stagnant markets for coated magazine papers; ad pages could even decline.

Late last year, Mead predicted magazine growth of 2.5% on average over the five years through 1992. Magazines will use 51% of the coated groundwood and 18% of the coated free-sheet paper produced.

Some periodicals, such as Sunday newspaper magazines, which formerly used uncoated groundwood papers or newsprint, have moved up to coated paper.

NEW CAPACITY COMING ONLINE. Commercial printing uses some 50+% of all coated paper production, about 2.9 million tons of coated paper in 1987. Included in the commercial printing sector are direct mail flyers and newspaper advertising inserts. Preprinted newspaper inserts are growing at a rate of about 5% to 7%/year. Use of coated paper for inserts is about 600,000 tpy, compared with 400,000 tons in 1986. Newsprint and uncoated groundwood grades make up the bulk of the remaining 2 million tons of paper used for inserts.

Book printing/publishing consumed about 300,000 tpy of coated paper in each of the years from 1984 through 1987. Demand may grow as much as 5%/year in the next one or two years. ■


A WHALE OF A PUMP®
I HAD A PROBLEM. McCAUSLAND HAD THE SOLUTION.
Customers find solutions with McCauslands' hydraulically driven submersible pumping systems. Quick response helps solve critical problems and reliable performance gets the job done.
McCausland pumping systems dewater, move muck, sewage, trash, chemicals, sludge, even food products fast and efficiently, with designed dependability.
They install quickly, run dry at any angle, and require no priming. For [illegible] a reputation for reliability have made McCausland the pumping system [illegible] performance driven users.
McCausland solution driven pumping systems: flexible, versatile. Quickly [illegible] manufactured. Call us, we'll prove it's A WHALE OF A PUMP.
A WHALE OF A PUMP
JACKSONVILLE, FLA.
JOHN E. McCAUSLAND INC.
CONTRACT PUMPING • RENTALS • MANUFACTURING • SALES • SERVICE • CALL 1-800-441-1975
On Reader Service Card Circle 144

BCTMP GROWTH, DEMAND TO CONTINUE WORLDWIDE DURING FUTURE DECADES

Technological advances, use of alternative wood species, and capital/operating advantages will fuel continued expansions

By PETER M. SHARMAN

The growth in capacity of market bleached chemi-thermomechanical pulp (BCTMP) has been a major topic of discussion around the world during recent months. This rapid product growth can be attributed to the following:

- Technological advances making possible the production of superior-quality, uniform pulp
- Higher capital and operating costs of chemical pulps for a given product
- The opportunity to utilize alternative wood species, such as low-density hardwoods, with their lower cost and technical advantages
- Technical advantages of BCTMP for end products.

Of the 20+ market BCTMP mills either in production, under construction, or in the detailed engineering phase, more than 90% of the tonnage (representing more than 2.5 million tpy) has already come online or will be coming online by the end of 1990. As of early 1989, a shortage exists not only of fully bleached chemical pulp but also of current third-generation-technology, high-quality BCTMP. Generation differences will be discussed later in this article.

BCTMP is defined in this article as pulp produced from mild chemically treated chips, bleached with peroxide, and having a total yield of 90+%. S-Pulp refers to a similar process with a patented chip "explosion device" ahead of refining and a yield in excess of 87%. Chemimechanical pulp (CMP) describes high-level, chemically treated chips that produce a pulp with a yield of 85+%. Figure 1 relates BCTMP to other types of pulp in terms of yield.

Early predictions of end uses for the various high-yield market pulp products have proved valid, and the list is growing considerably. Unbleached and commodity grades of market high-yield pulp have also played a role in the marketplace.

In addition to BCTMP, some market stone groundwood (SGW) is available; in the future, market pressurized groundwood (PGW) may be available, but this remains to be seen. In general, however, SGW, PGW, and thermomechanical pulp (TMP) will remain integrated within a multi-furnish mill complex.

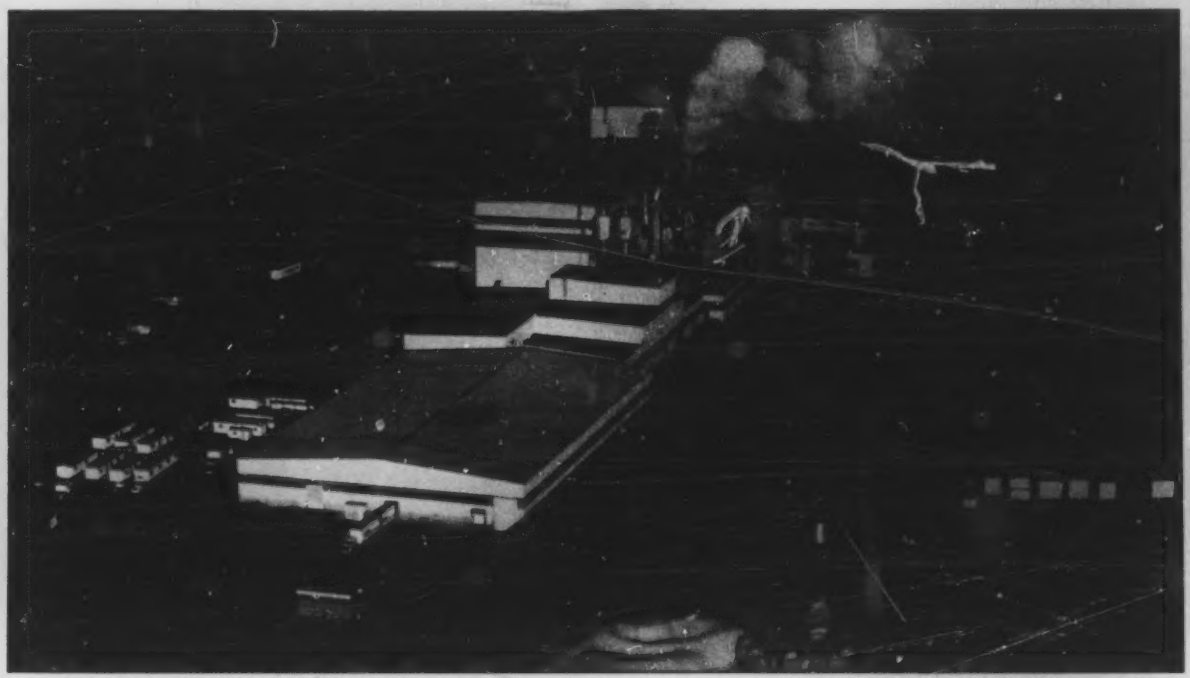
The predecessors, market refiner mechanical pulp

Mr. Sharman is vice president, Nystrom, Lee, Kobayashi Inc., Montreal, Que.

NOTE: All figures in this report are in metric tons.

FIGURE 1: **Where BCTMP fits into the world's paper-grade pulps.**

	Pulp	Yield (%)
Pure mechanical	SGW — stone groundwood	95 to 97
	RMP — refiner mechanical pulp	94 to 96
	PGW — pressurized groundwood	94 to 95
	TMP — thermomechanical pulp	91 to 94
The shrinking gap	CTMP — chemi-thermomechanical pulp	90 to 92
	S-Pulp — explosion	86 to 90
	CMP — chemimechanical pulp	85 to 90
	V/UHYS — very/ultra-high-yield sulfite	75 to 85
	SC — semichemical	65 to 85
	HYS — high-yield sulfite	55 to 75
True chemical	NSAQ — neutral sulfite anthraquinone	50 to 65
	— — soda anthraquinone	52 to 55
	— — alcell/organosolv	50 to 60
	SP — sulfite pulp	45 to 53
	KP — kraft (sulfate) pulp	42 to 50



Total nominal capacity of market BCTMP mills now operating, under construction, or currently on the drawing board totals some 2.75 million air-dry metric tpy (photo of Millar Western, Alberta, Canada, mill).

(RMP) and TMP mills, have disappeared, having either been shut down due to low quality or high cost, forward integrated into paper mills, or converted to BCTMP mills. Some TMP plants (both market and integrated) were, in fact, taken out of service and dismantled prior to technology being available for conversion to BCTMP. Examples include the following:

- Weyerhaeuser Paper Co., Everett, Wash.: fluff pulp
- Continental Forest, Augusta, Ga.: board
- Boise Cascade Corp., Rumford, Maine: lightweight coated (LWC)
- Gota, Sweden: market pulp.

CURRENT, POTENTIAL MILL STATUS. The Table 1 listing of current BCTMP suppliers includes mills now in operation, under construction, or on the drawing board as of the end of first-quarter 1989. Nominal production capacities are based on the higher-freeness grades.

The original BCTMP mills were built in Sweden for the domestic Nordic and European market to supply nonintegrated mills within a captive market. The trend to forward integration in Scandinavia, coupled with inherent high power costs, probably will make the construction of new market BCTMP mills in that part of the world unattractive. However, two or three mills possibly will be built in other parts of Europe.

The majority of the more modern mills (1986 to present) have been, and will continue to be, built in Canada because of lower energy costs and proximity to supplies of desirable wood species. This growth trend will be maintained until all available wood has been committed. Hardwoods, especially aspen, are also being vigorously sought by those looking to expand or construct bleached kraft pulp mills.

Another major geographical area for potential new market BCTMP mills is South America. Again, lower manufacturing costs and desirable wood species, such as eucalyptus and radiata pine, enhance this possibility.

Long-range potential for development, in addition to North and South America, exists in Australia and New Zealand. As in South America, technology has opened the door to this part of the world with its eucalyptus and radiata pine species. Winstone, New Zealand, has already operated for several years with a furnish of radiata pine.

The southern pines of the southeast U.S. may provide future potential with continued advancements in technology. Celulosa y Papel, Mexico, will be one of the proving grounds for pine species; it utilizes the higher-pitch-containing ponderosa pine for several grades.

End-product utilization will be limited for a number of years for pulps from a majority of pine species until, as suggested previously, further strides are made in process technology. However, it is important to remember that only a few years ago, 100% southern pine newsprint was not believed feasible.

TABLE 1: **Current world market BCTMP mills.**

Company/location	Mill startup year	Nominal production a.d. tpy	Mill status early 1989	Number of refiner lines	Number of refining stages	Process technology generation	Pulp dryer type	Predominant wood species	Principal end products	Product principal markets
Rockhammars Bruk, Sweden[1]	1978	50,000	Operating	1	2	2	Flash	Spruce/aspen	P&W/B/T/F	E
Billerud, Sweden[2]	1981	35,000	Operating	1	1	1	Airborne	Spruce	F	E
SCA, Sweden	1982	65,000	Operating	2	1	1	Flash	Spruce	T/F	E/C
Melhoramentos, Brazil	1982	10,000	Operating	1	2	1	Wet lap	Eucalyptus/pines (mixed)	P&W/T	SA/C
Quesnel River, British Columbia[1,2]	1982	90,000	Operating	1	2	2	Flash	Spruce/pine (lodgepole)	P&W/T/F	NA/A
Winstone, New Zealand[1,6]	1983	85,000	Operating	2	2	1	Flash	Pine (radiata)	P&W/B/T	A
Opua, Spain[6]	1983	50,000	Noncontinuous	2	2	1	Flash	Pine (radiata)	Newsprint	E
Folla, Norway	1984	80,000	Operating	2	2	1	Flash	Spruce/aspen	P&W/B/T/F	E
Rottneros, Sweden[1]	1984	60,000	Operating	1	2	2	Flash	Spruce/aspen	P&W/T	E/A
Modo/Iggesund, Sweden	1985	75,000	Operating	1	1	1	Airborne	Spruce	B/T/F	E/C
Serlachius, Finland	1985	70,000	Operating	2	1	1	Airborne	Spruce/aspen	B/T/F	E/C
Temcell, Quebec[3]	1986	95,000	Operating	1	2	2	Flash	Aspen/spruce	P&W/B/T/F	NA/A
Cascades, Quebec[3]	1987	165,000	Operating	3	2	2	Can	Spruce	P&W/T/F	NA/E/A
Celulosa y Papel, Mexico[6]	1987	80,000	Operating	1	2	1	Flash	Pine (ponderosa)	T	NA
Caxton, New Zealand	1987	90,000	Operating	1	2	1	Airborne	Pine (radiata)	P&W/B/T	A/C
Millar Western, Alberta	1988	210,000	Operating	2[4]	2	3	Flash	Spruce/pine (lodgepole)/aspen	P&W/B/T	NA/E/A
Fibreco, British Columbia	1988	180,000	Operating	2[4]	2	3	Flash	Spruce/pine (lodgepole)	P&W/B/T	NA/E/A
Quesnel River, British Columbia	1988	105,000	Operating	1	2	3	Flash	Spruce/aspen	P&W/B/T	NA/A
Vaggeryd Cell, Sweden	1989	70,000	Operating	1	2	2	Flash	Spruce	P&W/B/T/F	E
Cascades, Quebec[3]	1989	100,000	Operating	1	2[5]	2	Can	Spruce	P&W/T/F	NA/E/A
Consolidated-Bathurst, New Brunswick[2]	1989	90,000	Operational	1[4]	2	3	Flash	Spruce/balsam	P&W/B/T	NA/E
Donohue, Quebec	1990	190,000	Construction	4[4]	2	3	Flash	Spruce/balsam	P&W/T/F	NA/E
Celulosa y Paper, Mexico[3,6]	1990	80,000	Construction	1	2	2	Wet lap	Pine (ponderosa)	P&W	NA/C
Alberta Energy, Alberta	1990	120,000	Design	1	3	3	Flash	Aspen/spruce	P&W	NA/A
Nortek, Saskatchewan[7]	1990	100,000	Design	1	2	3	Flash	Aspen	P&W/B/T	NA/E/A
Millar Western, Saskatchewan	1991	240,000	Design	2[4]	2	3	Flash	Aspen	P&W/B/T	NA/E/A
Louisiana-Pacific, British Columbia	1991	170,000	Design	2	2	3	Flash	Aspen	P&W/T	NA/A
	TOTAL	**2,750,000**								

1. Converted from TMP.
2. Mill has one additional captive line.
3. Percentage captive in future.
4. Interline fiber fractionation.
5. Single refiner—two stages.
6. Some unbleached.
7. S-Pulp (exploded process).

LEGEND:

P&W = Printing/writing
B = Paperboard
T = Towel/tissue
F = Fluff

NA = North America
SA = South America
E = Europe
A = Asia

C = Some captive

Figure 2 shows current world wood species by country for present and planned market BCTMP mills. Table 2 lists market BCTMP mills and expansions being planned as of early 1989.

It is interesting to note that both Tables 1 and 2 include new companies and investors—previously unknown in the industry, who have embarked on ventures in this relatively new market pulp. It is probable that some of these market BCTMP plants will forward integrate within the next few years, especially those strictly

TABLE 2: **Potential world market BCTMP mills (planned/announced) to end of first-quarter 1989.**

Company/location	Nominal production a.d. tpy	Predominant wood species
Temcell,[1] Quebec, Canada	120,000	Aspen/spruce
San Augustine,[2] Texas, U.S.	190,000	Pine (southern)
Battistella,[2] Brazil	100,000	Pine (loblolly)
Confidential, (Taiwan), Alberta, Canada	240,000	Aspen/spruce
SPBBS,[3] Quebec, Canada	100,000	Aspen/spruce
Celulosa, Santa Monica, Argentina	75,000	Pines (ponderosa/lodgepole)
Confidential, Mississippi, U.S.	200,000	Pine (southern)
Crossen, German Dem. Rep.	60,000	Spruce/aspen/pine (scotch)
Serlachius, Finland	25,000	Spruce/aspen
Fibreco,[2] British Columbia, Canada	180,000	Aspen/spruce
Papel Misionero, Argentina	30,000	Eucalyptus (grandis)
Essex, Labrador, Canada	180,000	Spruce
SCA, Sweden	65,000	Spruce
Shinho (Korea), Ontario, Canada	120,000	Aspen
Winstone, New Zealand	55,000	Pine (radiata)
Confidential, (People's Rep. China) Ontario, Canada	100,000	Aspen
Suzano/CVRD, Brazil	30,000	Pine (Caribbean)/eucalyptus (mixed)
Confidential,[2] West Virginia, U.S.	100,000	Poplar (yellow)
Confidential, Chile	100,000	Pine (radiata)
Confidential,[3] New York, U.S.	100,000	Aspen
Consolidated-Bathurst/Massuh,[2] Argentina	100,000	Eucalyptus (grandis)
Confidential,[3] Thailand	50,000	Eucalyptus
Confidential,[3] Nova Scotia, Canada	100,000	Aspen/mixed hardwoods
Confidential,[4] Norway	40,000	Spruce/aspen
Confidential, California, U.S.	100,000	Eucalyptus (grandis)
Confidential, Arkansas, U.S.	175,000	Pine (southern)
Andinos, Chile	100,000	Pine (radiata)
Cascades, Quebec, Canada	120,000	Aspen/spruce
Asitka, British Columbia, Canada	250,000	Mixed softwoods
Confidential, British Columbia, Canada	200,000	Spruce/aspen
TOTAL	**3,405,000**	

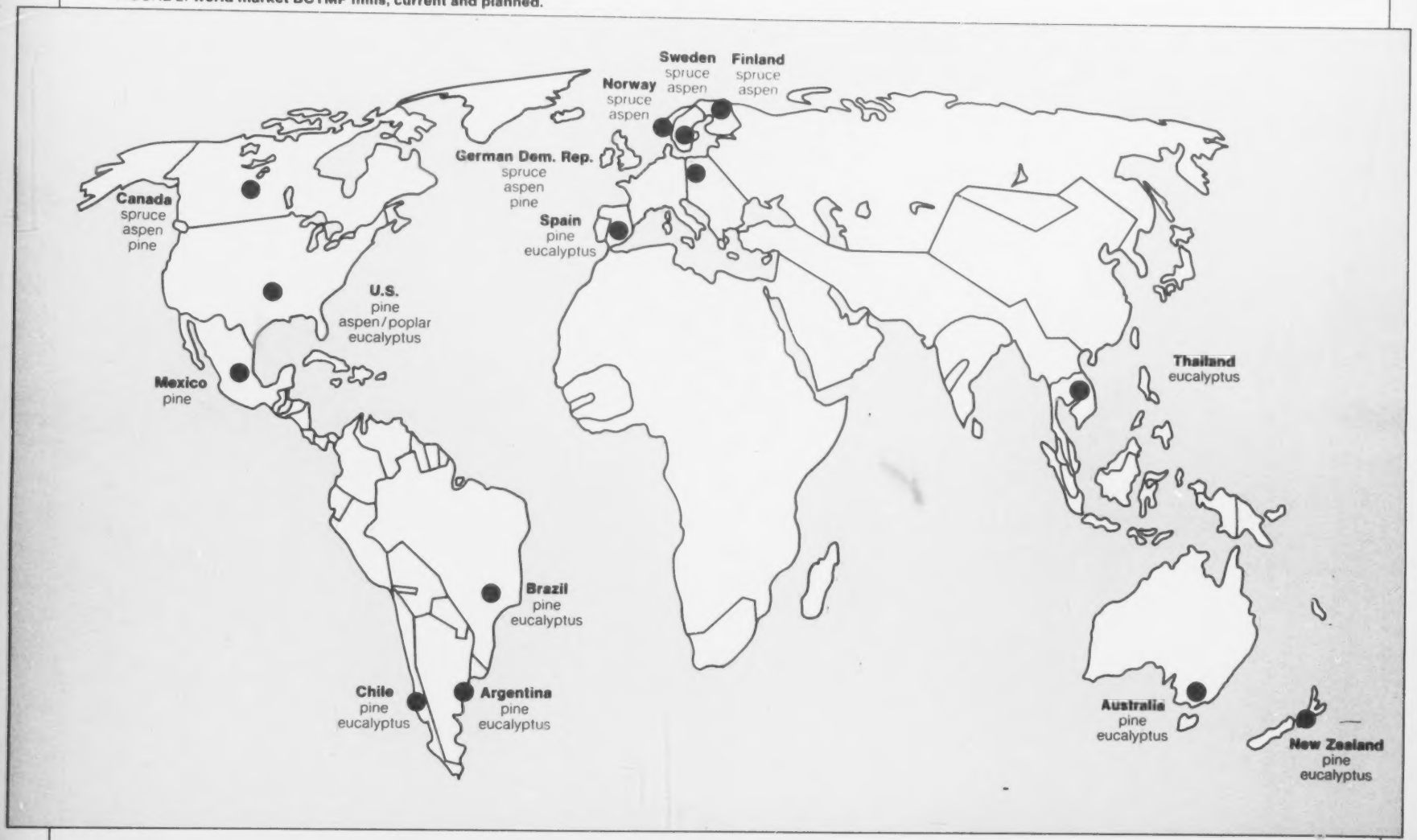
1. Additional possibility with St. Raymond Paper, Quebec. 2. Forward integration in near future.
3. S-Pulp mill (exploded pulp process). 4. Conversion to CTMP.

TABLE 3: **World paper-grade pulp capacity, market and integrated (softwood and hardwood, 000 tons).**

Pulp	1987	1988	1989	1990	1991	1992	Average growth 1987–92
Bleached kraft	58,270*	59,650	61,370	64,400	65,860	67,350	2.6%
Unbleached kraft	38,730*	38,820	38,770	38,790	39,110	39,110	0.2%
Sulfite	10,710	10,490*	10,620	10,490	10,490	10,490	−0.3%
Other chemical, including semichemical	24,460*	24,500	24,540	24,780	24,780	24,780	0.2%
CMP/(B)CTMP	5,050*	6,000	6,740	7,250	7,490	7,590	8.4%
SGW/PGW/RMP/TMP	33,950*	35,270	37,010	37,950	38,240	38,400	2.2%
World total	171,170	174,730	179,050	183,660	185,970	187,720	
Annual growth rate		2.1%	2.5%	2.6%	1.3%	1%	1.6%

Source: Celpap (except *: FAO)

FIGURE 2: **World market BCTMP mills, current and planned.**



utilizing softwoods.

Table 3 outlines world paper-grade pulp capacity for both market and integrated mills. BCTMP capacity, since it came on the world market and projected to 1992, is shown in Figure 3. Current and potential world market BCTMP capacity by region is shown in Figure 4. The world's total paper-grade market pulp capacity (history and immediate forecast) is shown in Table 4. Table 5 summarizes the history and immediate forecast for the world's various high-yield pulp utilization, both market and integrated.

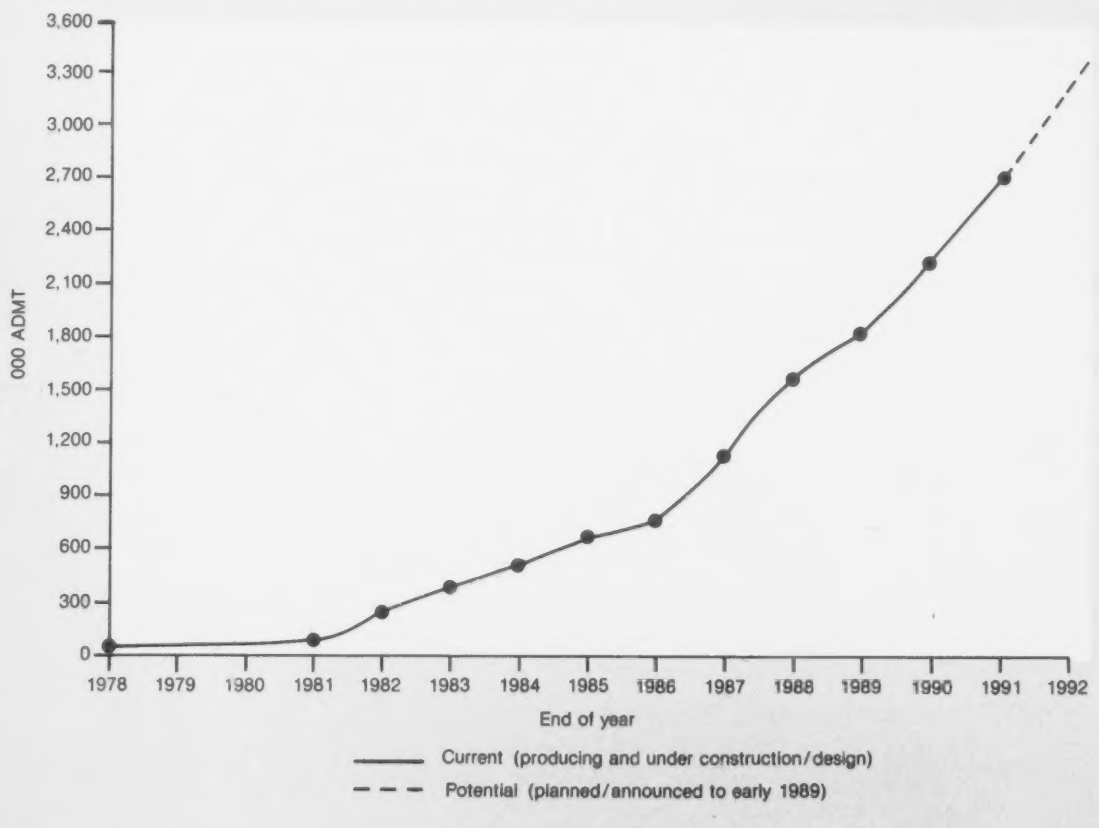
END USES. The early BCTMP mills provided the limited market of chemical pulp replacement for towel, fluff, and certain lower-quality tissue grades. Opportunities in this market have become diluted with the in-

TABLE 4: **World paper-grade pulp capacity history and forecast (softwood and hardwood).**

Pulps	End of year															
	1985		1986		1987		1988		1989		1990		1991		1992	
	%	a.d. tpy (000)	%	a.d. tpy (000)	%	a.d. tpy (000)	%	a.d. tpy (000)	%	a.d. tpy (000)	%	a.d. tpy (000)	%	a.d. tpy (000)	%	a.d. tpy (000)
(B) CTMP	2	670	3	770	4	1,010	6	1,570	7	1,830	8	2,220	9	2,700	10	3,300
(B) SGW	4	800	3	750	3	700	3	650	2	650	2	600	2	550	2	550
Bleached kraft	94	22,500	94	22,500	93	23,200	91	23,500	91	24,600	90	26,400	89	27,800	88	29,100

Source: Celpap. All tons are metric.

FIGURE 3: **World market BCTMP capacity history and forecast.**



creased capacity during recent years. Paperboard, including liquid packaging, has generally been in a captive market to date.

The future growth in utilization of market BCTMP lies in the displacement of other types of pulp in existing products and in the creation of new end products. To promote growth in the utilization of existing grades and to achieve a larger percentage of the product in new grades, certain quality criteria will have to be met. In addition to the desirable technical advantages of BCTMP, several unacceptable pulp properties must be *consistently* eliminated. Some of these are summarized in Table 6.

Key factors that will encourage further utilization include the following:

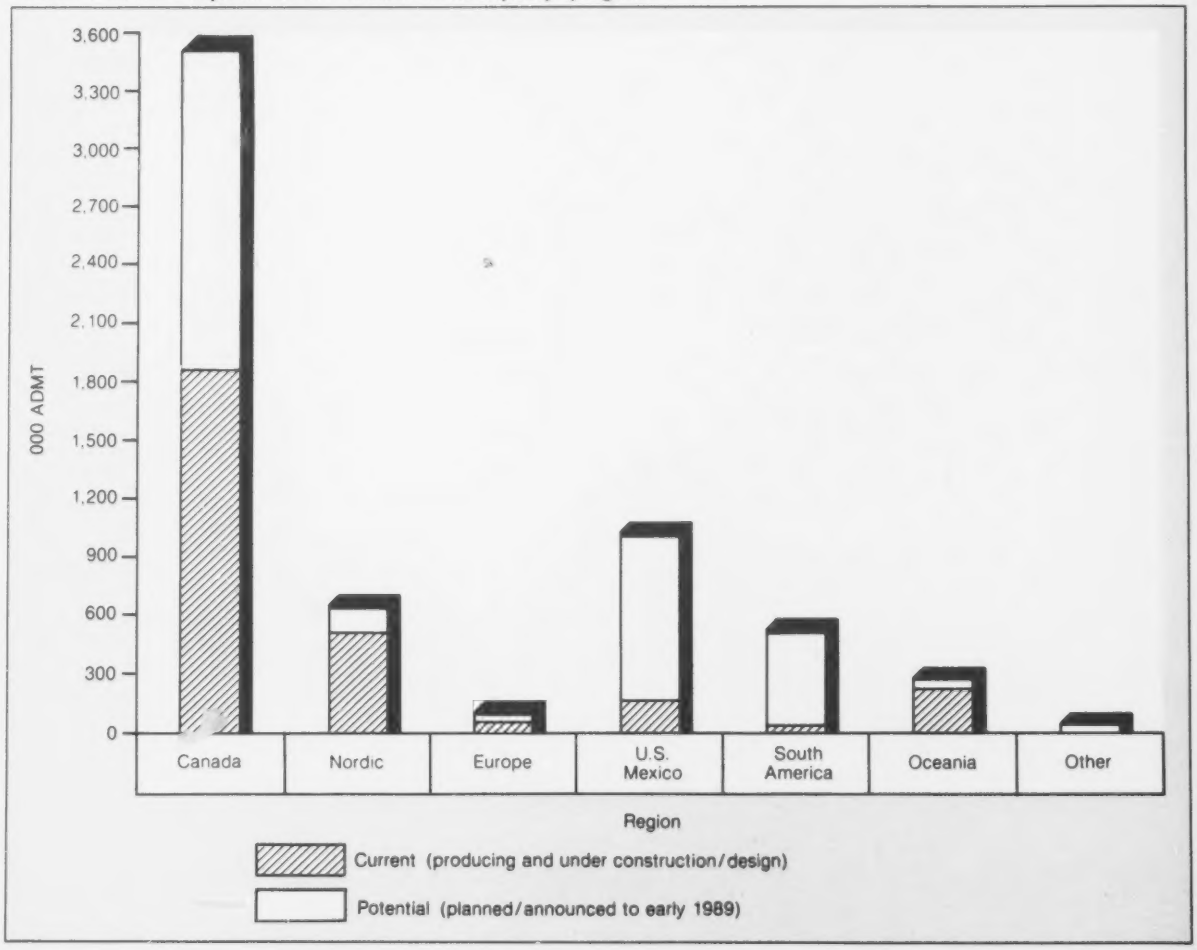
- Uniformity of quality
- Higher freeness/better runability
- Higher brightness
- Lower reversion
- Lower extractive levels
- Proper marketing
- Wood-free grade definition that allows performance basis, not furnish.

TABLE 5: **World high-yield pulp use, market and integrated.**

Pulp	000 a.d. metric tpy 1979	1984	1989	1992*	Future trend
(B) SGW/RMP	24,200	15,700	13,700	12,500	Declining (integrated and market)
PGW/ (B) TMP	4,900	10,200	13,700	16,400	Increasing (integrated)
(B) CTMP/ (B) CMP	800	3,200	6,400	7,200	Increasing (integrated and market)

Sources: Ekono/PPI
*Celpap

FIGURE 4: **Current and potential world market BCTMP capacity by region.**



The world trend in market pulps is toward hardwood grades, which are characterized by short, fine fibers. Eucalyptus chemical pulps (once considered as a filler) have paved the way toward the use of shorter-fiber pulps to enhance product quality; strength is sacrificed to gain other advantages, such as better formation and printability or improved softness. Hardwood BCTMP has shown similar attributes when compared with softwood BCTMP. In addition, hardwood BCTMP displays superior bleached brightness and lower reversion.

Because of the technical advantages of hardwood BCTMP compared with softwood BCTMP, northern paper producers will move to higher-value grades containing hardwood BCTMP. Softwood grades will be used to a greater extent as a reinforcement component and in products requiring high bulk.

As pulp strength and shive levels improve, it is becoming possible to manufacture higher-freeness pulps for a given end-product application. Such increases in pulp freeness lead to improved drainage and, consequently, better paper machine runability for lower-freeness grades.

Brightnesses of 85+% ISO are achievable with certain species at economical chemical consumptions. But these higher brightnesses are not required for many products, especially when lower substitution percentages of BCTMP apply. Most North American printing paper is produced in the 82% to 88% ISO range. Reversion, cleanliness, and extractive levels are often more important; these have been improved drastically as a result of evolution of technology. Requirements such as repulpability, absorbency, taste/smell elimination, and fines level reduction have also all improved considerably with technology advancements. These attributes have recently brought softwood BCTMP into use for diaper manufacture in Europe; the marketing program exploits the dioxin in chemical pulps issue.

The industry is getting closer to the entry of BCTMP into higher-quality grades of tissue. Current BCTMP, especially softwood, offers good bulk, and this is one factor. However, softness is an essential requirement. The best tactile (touch) softness is currently achieved with debonded eucalyptus chemical pulp. Hardwood (aspen/eucalyptus) BCTMP is better than softwood BCTMP in this regard, and continuing technology development will lead to further improvements, resulting in wider application of BCTMP for tissue and towel grades.

BCTMP has both advantages and disadvantages when compared with chemical pulps in producing absorbent grades of paper products. The relative stiffness and bulk of CTMP, especially after wetting, provides increased absorbent capacity in a tissue, towel, or napkin. However, the presence of minute quantities of wood resins (the amount of which varies by wood species) or other fatty chemicals in the pulp inhibits the rate of absorbency in the final product. The relative importance of absorbent capacity vs rate varies by product and can be significantly influenced by paper structure as well. Good pulp washing, bleaching, and chemical treatments tailored to different wood species are necessary. Of the wood species used for absorbent pulp applications, northern spruce BCTMP has been the most successful.

The gap between newsprint, specialties, LWC, medium-weight coated (MWC), and supercalendered grades is

TABLE 6: **BCTMP end-use property requirements.**

	BCTMP properties	
Grade	**Acceptable**	**Unacceptable**
Printing and writing	High bulk	High shives
	High stiffness	Poor runability
	High opacity	High reversion
	High surface strength	Surface roughness
	Good formation	High dusting/linting
	Good printability	Poor dimensional stability
Paperboard	High bulk	High extractives
	High stiffness	Poor runability
	Good printability	Low ply bond
	Low shives	Taste/odor
Towel	High bulk	High shives
	High absorbency	Poor runability
	High brightness	High fines (dust)
	Hardwood improves softness	High extractives
Tissue	High absorbency	High shives/coarseness
	High brightness	Poor runability
	Low silicate content	High fines (dust)
	Hardwood improves softness	High extractives
Fluff	High bulk	High shives
	High absorbency (rate and capacity)	High fines (dust)
	High brightness	High reversion (yellowing)

shrinking due, in part, to improved high-yield pulp quality. Newsprint is largely a specialty grade now, or is becoming so, even in areas where wood quality is poor. This has arisen from the need for high-quality, four-color printing. High-quality market BCTMP will satisfy the requirements of certain higher-value grades, both when "today's specification" pulp enters the market and when those few paper producers and end users fully realize the advantages. Then the printing and writing rush will begin.

It is widely agreed that the largest potential market for BCTMP grades is in this area of certain printing and writing paper. In addition to conventional high-yield-pulp-containing paper, such as LWC, the immediate possibility is for commercial grades, such as business forms, computer listings, and copy paper, along with some book paper and several general printing paper applications. Technology will soon solve such concerns as heat curl and dusting. A greater opacity will be required for double-sided copy machines. The current "wood-free rule" (i.e., a maximum of 10% mechanical pulp to qualify as a "free" sheet) clearly poses a marketing barrier to penetration of BCTMP in the printing and writing paper sector. With the advent of high-quality, high-yield pulps now available in significant quantities, and in spite of resistance in the industry, new grades will evolve to accommodate increasing supplies of BCTMP, regardless of this rule.

Pressure to drop this will come from nonintegrated papermakers, who will use increasing quantities of BCTMP to lower furnish costs. It is likely that they will develop specific intermediate grades of paper with their own brand names to circumvent this definition. Similarly, pressure to utilize more secondary fiber in paper will encourage modification of the rule due to the difficulty in controlling the quality of the wastepaper. It is hoped that the industry soon will eliminate such terms as "slightly wood-free" or "part mechanical."

Table 7 indicates world market BCTMP consumption percentages by grade and region. Estimated world consumption tonnages and percentages by grade from 1984 and forecast to 1992 are shown in Table 8. The approximate supply and demand balance for market BCTMP is shown in Table 9.

The current world CTMP (i.e., bleached and unbleached) major product end usage is shown in Table 10. It clearly indicates high growth over the short time period during which significant quantities of high-quality BCTMP have been available.

Due to declining landfill site availability in certain parts of the world and the depletion of accessible forest resources, legislation is increasing regarding biodegradables and recycling. In the near future, many products made with only virgin fiber will be taxed accordingly.

New secondary-fiber process technology is targeting use in higher-value products; one example is improved peroxide bleaching for recycled fiber. Competition from secondary fiber as an alternate replacement for chemical pulps is strong.

In the longer term, increased pressure to use recycled fiber will reduce secondary fiber raw material quality. This will result from an increased average number of recycles and the recycling of lower-quality products. As this happens, BCTMP will become an attractive reinforc-

TABLE 7: **Estimated world market (B)CTMP consumption by grade and region.**

Grade	Europe (EC)		Nordic		North America		South America		Asia/Oceania/ other	
	1987	1992	1987	1992	1987	1992	1987	1992	1987	1992
Printing and writing	46%	78%	23%	29%	26%	61%	35%	50%	20%	26%
Newsprint/specialties	8%	1%	0%	0%	0%	2%	0%	0%	60%	50%
Paperboard	2%	1%	15%	9%	0%	0%	15%	10%	5%	5%
Towel/tissue	28%	14%	15%	17%	74%	37%	50%	40%	15%	16%
Fluff	16%	6%	47%	45%	0%	0%	0%	0%	0%	3%
000 tons	245	840	65	90	95	410	20	50	205	310

Source: Celpap.

TABLE 8: **Estimated world market (B)CTMP consumption by grade (total tonnage and percentages).**

Grade	1984		1987		1988		1992	
	000 tons	%	000 tons	%	000 tons	%	000 tons	%
Printing and writing	50	10	200	32	265	33	1,030	61
Newsprint/specialties	265	50	140	22	180	22	170	10
Paperboard	50	10	30	5	35	5	40	2
Towel/tissue	130	25	190	30	240	30	360	21
Fluff	25	5	70	11	80	10	100	6
Totals	**520**	**100**	**630**	**100**	**800**	**100**	**1,700**	**100**

Source: Celpap.

ing pulp component for certain products due to its low cost and compatibility with recycled fiber.

An additional increase in utilization of lower-cost pulps, including both recycled fiber and BCTMP, will result from replacement of nonbiodegradables, such as plastic and Styrofoam containers for packaging. The fast-food industry is a good example. Several companies have announced the discontinuation of products containing chlorofluorocarbons (CFC), sparked primarily by the thinning ozone layer issue. CTMP and secondary fiber will be the natural furnishes to resolve many of these concerns.

MARKET AREAS. Europe has long been established as the major current market for BCTMP, although tonnage is small compared with other furnishes. There are a few examples of backward integration to BCTMP after companies had used the purchase of market BCTMP as their pilot plant since BCTMP is sold as a tailor-made pulp. Europe will be supplied with more capacity from North America and, eventually, South America as available Scandinavian tonnage declines due to forward integration of their BCTMP mills.

The North American market is growing slowly for three main reasons:

1. The lack of significant quantities of available high-quality BCTMP
2. Resistance in the printing and writing sector, discussed previously, vs the saturation of the towel/sanitary tissue market
3. The comparatively low amount of recycled fiber used to date.

This year will prove the potential and set the trends for the future in the printing and writing sector because of the availability of high-quality pulp now entering the market.

Asia has been an increasingly active purchaser of BCTMP. Again, due to the lack of high-quality market pulp to date, Japan has been the slowest region to react to the entry of BCTMP into some of its higher-quality products.

Market proximity has not, as yet, been a key factor. This will change if, and when, more market BCTMP mills are built in the southeast U.S., South America, and Oceania, for example. Table 1 indicates the predominant market areas for the current mills.

The differences in market requirements for various geographical areas can be indicated by some printing and writing trends in three market regions:

- Europe—favors brightness/smoothness

TABLE 9: **Approximate supply/demand balance for world market (B)CTMP.**

Item	000 tons 1987	1988	1989	1990	1991	1992
A. Installed capacity (average)	940	1,480	1,700	1,890	2,070	2,070
B. Available capacity	700	850	1,470	1,700	1,880	2,070
C. Consumption	630	800	980	1,180	1,400	1,700
D. Utilization rate (C/B)	90%	94%	67%	69%	74%	82%

Captive market tonnages excluded.
Source: Celpap.

TABLE 10: **Major end-product world (B)CTMP usage (early 1989—top end of quality).**

Printing and writing	% (B)CTMP	Board	% (B)CTMP	Tissues	% (B)CTMP	Fluff	% (B)CTMP
Newsprint/specialties	100	Boxboard	50	Toweling	50	Diapers	100
Magazines	65	Foodboard	50	Sanitary	60	Sanitary pads	100
LWC/MWC	65	Liquid packaging	50	Facial	0		
SC	80	Linerboard	35	Filter	90		
Pocket book	100	Folders	70				
Reproduction (copy)	80	Chipboard	15				
Computer (listing)	50	Molded products	50				
Business forms	40						
Hardcover books (fiction)	40						
Reply card	60						
30 to 250		200 to 400		350 to 550		550 to 650	
		Freeness ranges (CSF)					

Percent is of fiber content.
Hardwood BCTMP % is lower for board and printing and writing grades.

- North America—favors opacity/strength
- Japan—favors opacity/smoothness/strength.

In the case of diapers, use of BCTMP has been successfully promoted to consumers in Scandinavia and Europe as a dioxin-free pulp. However, since the advent of consumer-preferred, superabsorbent-containing, thin diapers, the importance and quantity of woodpulps used in this application have declined significantly. Dioxin concerns may result in some increased use of highest-quality BCTMP in diapers in North America. Longer term, diapers may not be the promising market envisioned.

WOOD SPECIES AND PULP PROPERTIES. Woodfiber morphology and resin content for the predominant wood species used currently and planned for BCTMP are indicated in Table 11. The following are generally true:

- Long fiber length equals high tear but low printability and poorer formation.
- Short fiber length equals good paper smoothness and opacity but low tear.
- Small fiber diameter equals improved printability, opacity, and softness.
- Large fiber diameter equals high bulk but reduced smoothness and printability.
- Thick fiber wall equals lower tensile, higher linting, and reduced smoothness.
- High nonfiber content (vessel ray cell) equals higher linting and dusting.
- High wood density equals high energy requirements, with high chemical applications required.
- High extractives equals low brightness, high reversion, poor bonding, and poor absorbency.

The early, higher-quality BCTMP mills, especially in Scandinavia, used spruce as the raw material. Product qualities from early mills that used higher percentages of pine species were poorer. Better processing techniques have helped to improve pulp quality from all softwood species, especially the higher-resin-containing pines.

The use of low-density hardwoods, in general, requires a fine balance between the strength, brightness, and opacity requirements and the energy and chemical input. Higher-density hardwoods, such as birch and beech, will necessitate a lower yield for given pulp qualities.

Currently, the use of aspen and eucalyptus BCTMP has considerable promise for inclusion in printing and catalog paper. The higher bulk (lower density) of BCTMP-containing sheets provides more printing surface per ton of pulp. The enormously increased number of finer, shorter fibers per gram results in finished paper that is smoother, more uniform, more opaque, and less porous than wood-free paper made from chemical pulps.

Aspen and, in the future, eucalyptus command a premium price due to higher brightness and lower reversion levels as well as better paper smoothness, printability, and, in the case of tissue, better softness than BCTMP from softwoods. Hence, the North American and South American market potential due to the relatively large abundance of aspen and eucalyptus, respectively, is substantial. Oceania will also provide eucalyptus-grade BCTMP in the future. In addition to these advantages, eucalyptus is an attractive plantation species since its short growing cycle can keep the harvest area close to

TABLE 11: **World market BCTMP mills: typical wood morphology and resin characteristics.**

Species	Fiber length (mm)	Fiber diameter (μm)	Wall thickness (μm)	Wood density (kg/m³)	Alcohol-benzene extractives (%)
Softwoods					
Spruce—black (Canada)	3.5	25–30	2.2	400	2.2
Spruce—white (Canada)	3.3	25–30	2.4	368	2.0
Balsam fir (Canada)	3.5	30–35	2.5	340	2.5
Pine—ponderosa (Mexico)	3.6	35–45	3.4[1]	384	4.0–5.0[2]
Pine—lodgepole (Canada)	3.1	35–45	3.0	384	3.5
Pine—loblolly (southern U.S.)	3.6	35–45	3.5[1]	425	3.5–4.5[2]
Pine—radiata (Chile) *	4.0	35–45	variable	400	2.5
Pine—radiata (Oceania) *	3.5	30–45	variable	400	2.2
Hardwoods					
Aspen—trembling (Canada)	0.9	10–27	2.5	355	1.5
Eucalyptus—grandis (Argentina) *	0.8	17	2.9	440	1.3
Eucalyptus—saligna (Brazil) *	0.9	21	3.5	450	1.8
Eucalyptus—regnans (Australia) *	0.9	17	3.1	420	1.7

General: Because of the difficulty in generating a uniform, reliable database, these data are presented as typical only and are not definitive for any particular wood supply or species. The value of this information is that it shows the relative advantage that BCTMP producers have based on their wood resources.
1. Pine fiber wall thickness varies widely between early wood and late wood. These are average values.
2. Extractives content for these two species varies with growing conditions (climate, tree age, soil characteristics).

Source: Isenberg/Foelkel & Barrichelo (except *).

the mill location.

The radiata pines of South America, especially in Chile, and Oceania will become a major potential BCTMP species due to their high brightness and high tear. Current technology has raised and maintained quality considerably over the current mills utilizing this wood, although end products are still limited. Caribbean pine will be utilized in Venezuela to produce BCTMP for use in tissue grades (integrated).

Currently, interest in southern pine BCTMP is being renewed for the large domestic market in the southeast U.S. Again, technology is at a point that makes this viable (with brightnesses of 80% ISO obtainable at an economical cost), compared with even five years ago, when southern pine or ponderosa pine BCTMP potential was considered low.

Technology has advanced to the point that in the very near future, countries in parts of Africa and Asia will be building BCTMP plants using a variety of their wood species, particularly hardwoods.

Tables 1 and 2 indicate the predominant wood species for current and planned market mills. Figure 2 shows them by country. A typical comparison between the properties of a softwood and hardwood kraft, a softwood and hardwood BCTMP, and a hardwood S-Pulp is shown in Table 12.

It should be noted that extractive percentage is a crude and misleading figure since the crucial chemistry of the measured extractives varies by wood species and pulping chemistry/process. For example, 0.1% for spruce CTMP is not nearly as good as 0.1% for softwood or hardwood kraft for absorbent grades of pulp. End product use of pulp determines the acceptable figures.

The typical properties for BCTMP utilizing different softwood and hardwood species are indicated in Table 13. A BCTMP-containing paper property comparison with wood-free-grade printing and writing paper is shown in Table 14. The impact of using softwood and hardwood BCTMP in fine paper compared with softwood and hardwood kraft is shown in Table 15.

TABLE 12: **Typical pulp property comparison between BCTMP and chemical pulps.**

Property	Unit	BCTMP		S-Pulp[1]	Hardwood kraft	BCTMP		Softwood kraft
Species	—	75% aspen/ 25% spruce		Aspen	Aspen	Spruce		Spruce
Freeness, CSF	ml	100	400	240	400	100	400	400
Tensile index	Nm/g	65	50	77	75	67	48	120
Tear index	mN.m²/g	6.0	7.0	6.5	9.0	8.0	9.0	10.7
Burst index	kPa.m²/g	2.7	2.2	5.0	4.6	3.4	2.7	10
Bulk	cm³/g	1.9	2.2	1.6	1.5	2.1	2.8	1.3
Yield	%	89	89	87	50	91	93	43
Brightness, ISO	%	85	85	85	90	80	82	90
Opacity	%	78	71	70	71	82	79	65
Classification:								
+28	%	8	16	10	20	40	55	70
−200	%	22	20	14	10	24	16	8
Shives (Sommerville)	%	0.02	0.05	0.15	0	0.02	0.05	0

1. Unscreened—trial.

TABLE 13: **Typical BCTMP properties of various wood species.**

Property	Unit	Softwoods				Hardwoods	
Species	—	Black spruce	Southern pine	Ponderosa pine	Radiata pine	Aspen (trembling)	Eucalyptis (grandis)
Freeness, CSF	ml	400	400	380	400	110	125
Tensile index	Nm/g	48	30	32	44	50	52
Tear index	mN.m²/g	9.0	11.0	10.0	10.6	5.0	4.8
Bulk	cm³/g	2.8	3.6	3.3	2.9	1.8	2.1
DCM extractives	% (maximum)	0.10	0.12	0.11	0.10	0.05	0.10
Yield	%	93	92	92	93	89	88
Brightness, ISO	%	82	76	76	79	85	80
Opacity	%	79	80	81	83	16	80
Classification:							
+28	%	55	50	50	58	8	13
−200	%	16	18	20	17	20	18
Shives (Sommerville)	%	0.10	0.08	0.12	0.08	0.05	0.06

TECHNOLOGY. With the evolution of market BCTMP technology, it has been possible to divide the mills into three generations, as shown in Table 1. First-generation mills resemble newsprint mills with a pulp dryer instead of a paper machine. Chip preparation equipment (i.e., ahead of refining) and bleach plant equipment typically are of a vintage that was available prior to 1980. The original mills now have been upgraded technically and/or are using percentages of hardwoods, which are, as previously mentioned, desirable species.

Second-generation mills are characterized by the latest in chip preparation equipment ahead of refining, modern bleaching capabilities, and fractionation when multiple refiner lines have been installed.

Current third-generation mills typically include such technological advances as multistage impregnation, process chemistry variations, sulfonated long-fiber processes, interstage washing and bleaching, and multistage, multi-chemical bleach plants. Multiple refiner lines allow optimization of all pulp grades. The most recent developments involve patented multistage impregnation of chips combined with patented pulping chemistry based on the alkaline peroxide process, leading to pulps with unique physical and optical properties, including fiber length distribution characterized by very low fines content.

Future fourth-generation mills will be simpler, more economic, single-product operations. Growth and acceptance of BCTMP makes it possible for some mills to focus on more limited grades rather than requiring highly flexible specialty pulp production. Use of sheet dryers instead of more flexible flash dryers is expected in some of these mills.

Design aspects of the chipping, chip screening, and chip preparation systems have been influenced by the goal of feeding the process with chips of uniform size, moisture content, temperature, and chemical concentration, as well as low resin content; these factors are known to influence pulp quality. For instance, a trend is being seen in modern chipping and chip screening systems to minimize chip fines generation while maximizing chip size uniformity.

Chipper knife protrusion is maximized, which favors production of more large chips and fewer fines. Chips are sent to a chip thickness screening system from which the overthick fraction is directed to a slicer. Since properly maintained slicers display lower fines generation than chippers, this practice leads to relatively fewer small chips and chip fines.

A trend is also emerging toward lower bark levels in chips, more efficient chip washwater recycle systems, and mill water usage strategies that recycle whitewater back through the chip washer. This trend is driven by the requirement for higher brightnesses and extremely low dirt content for grades used in personal hygiene products and fine paper. Purchased chip specifications have been tightened up considerably to allow consistently high-quality pulps to be manufactured.

TABLE 14: **Property comparison between BCTMP-containing and wood-free printing and writing paper.**

BCTMP Property	Comparison with wood-free grade	Property comments
Cleanliness	Similar	Solved by pulp mill technology
Strength	Similar	High tensile/low tear
Stiffness/bulk	Better	Enhanced effect in layered paper
Brightness	Lower	Marginal effect with hardwoods
Opacity	Better	Improved further by fractionation
Reversion	Problem	Less with hardwood, no standard measurement
Dusting/linting	Former problem	Improved by pulp mill technology
Roughness	Potential problem	Can be compensated by pulp mill technology
Shives	Potential problem	Can be compensated by pulp mill technology
Grammage	Lower	For same opacity/bulk and stiffness

TABLE 15: **Typical comparison between BCTMP-containing and wood-free fine paper.**

Furnish/property	Unit	BCTMP	BCTMP	Chemical
Eucalyptus BCTMP	%	90	—	—
Aspen BCTMP	%	—	90	—
Softwood kraft	%	10	10	50
Hardwood kraft	%	—	—	50
Basis weight	g/m²	88	85	86
Ash content	%	13.5	13.5	13.6
Density	kg/m³	640	660	745
Tensile index, √MD.CD	Nm/g	37.6	35.0	31.6
Tear index, √MD.CD	mN.m²/g	5.6	5.7	6.3
Brightness, ISO	%	82.5[1]	81	80
Opacity	%	91.5	90.9	90
Roughness, bendtsen	ml/min	260	200	137

1. Contains optical whitener.

For high-freeness absorbent pulp grades in particular, the market demands low resin content. Low resin content is also required in certain printing grades to avoid fiber "pick-out" problems due to poor fiber-to-fiber bonding caused by retained resins. For other grades, paper machine water systems can incorporate pitch control chemistry to alleviate problems. For such end-use applications, resin content of pulps is less critical. Resin removal may be performed both on chips by squeezing in screw feeder devices and in pulp by effectively washing pulps throughout the refining and bleaching processes. Displacement-type wash presses are now available for this purpose. Pitch should be removed by cleaning the interstage washwater. Further technology development is under way for this important subject.

Most CTMP processes use two or three stages of refining, depending on the application. The selection of refining systems normally involves low-intensity refiners (large refining surface area). Such refiners produce pulp with superior bonding and longer average fiber length than those with a smaller disc diameter.

Treatment of high-freeness pulp after the chip refiner is becoming more common. Such treatment may consist of washing, chemical treatment and washing, or interstage bleaching and washing. Interstage treatment and washing is effective for removing resins and pulping chemicals and can enhance the performance of the subsequent refining equipment. Reject or long-fiber sulfonation is another alternative.

The initial bleaching and pulp washing, in what can now be described as a brightening "sequence," may take place in the refiner plant. Modern CTMP bleach plants are built for high-consistency (25+%) or medium-consistency (10+%) operation or a combination of the two. Bleach liquor and washwater circulation schemes are usually countercurrent, adding fresh chemicals largely in the last stage and sewering from the first stages.

The current marketing success of aspen BCTMP has provided promise and considerable activity in expanding the supply of this grade. The differences in fiber morphology bring new challenges for process and equipment suppliers. Fine fiber aspen responds better to different chip chemical treatment, especially higher alkali application. The presence of alkali and much smaller fiber dimensions (vs softwoods) significantly affects refiner operation. A minor fraction of softwood fibers co-refined with aspen has yielded good pulp quality and marketing results. Interstage treatment is effective in removing the alkali early in the process.

In modern, flexible, high-yield market pulp mills designed on the two-line concept, one production line can produce a high-freeness product while the other produces a lower-freeness product. The refiner plant operation in such mills is dictated largely by the objective of producing the correct proportions of each fiber fraction (i.e., long fiber, middle, fines) to meet the needs of the mill without making a surplus of any one fraction. To assist in refiner plant operation, plate distance sensors and pulp quality monitors are becoming more common. Currently, these units are used mainly for process monitoring to aid in providing a basis for operating decisions. The screening plant now performs the function of a fiber fractionation plant, which sends long-fiber fractions to the high-freeness line and short-fiber fractions to the low-freeness line (i.e., with no surplus of fines). The process design must be adaptable to the different morphologies of varying wood species.

The flexibility of the BCTMP process allows production of grades of BCTMP with selected properties close to either mechanical or chemical pulps but always with other properties moving in the opposite direction (e.g., higher fines give better formation but lower tear; more chemical impregnation to improve strength leads to lower yield, etc.). Adequate online process control and operational stability in the refiner plant and fractionation system are essential since changes in the screen reject rates lead to rather rapid variations in pulp quality.

Pulp pressing equipment, fluffing devices, and drying technology have been improved to enable repulping without fiber bundles or "knits." This has solved such previous end-use problems as "fish eyes" in the paper. Squeezing and pressing the fine hardwood fibers can cause formation of fiber bundles, which are unacceptable for fine and printing grades of paper. Close attention to selection and operation of process pulp pressing equipment is required to avoid such problems.

Although initially a problem, repulpability has improved dramatically. Flash-dried bales of pulp, especially mechanical pulps, take longer to repulp than do sheeted pulps. This is a function of the time required to wet and slough off fiber from the sides of a whole bale vs easier water penetration into unbundled sheets. The poorer wetability of most CTMP, compared with chemical pulp, has also been a factor. However, the cost of repulping facilities for a user mill with a small capacity having the opportunity of using small amounts of BCTMP must be compared with the end-product production cost and technical advantages. Airborne dryers are now used by several companies to allow rolled dried pulp to be marketed. Note that all BCTMP to date is marketed in flash-dried or airborne-dried form (Table 1), with the exception of one company each in Brazil and Mexico (wet lapped) and another company in eastern Canada, which "can dries" the product on a converted sulfite pulp cylinder dryer.

The driving forces for technological improvements have come mainly through refiner and chemical suppliers and consultants rather than directly from the market and pulp and paper producers. Early pulp user experiences with BCTMP uncovered problems or opportunities that served as the basis for developments. Published experiences from BCTMP users have been limited, although suppliers and consultants have been generally effective in providing nonproprietary feedback.

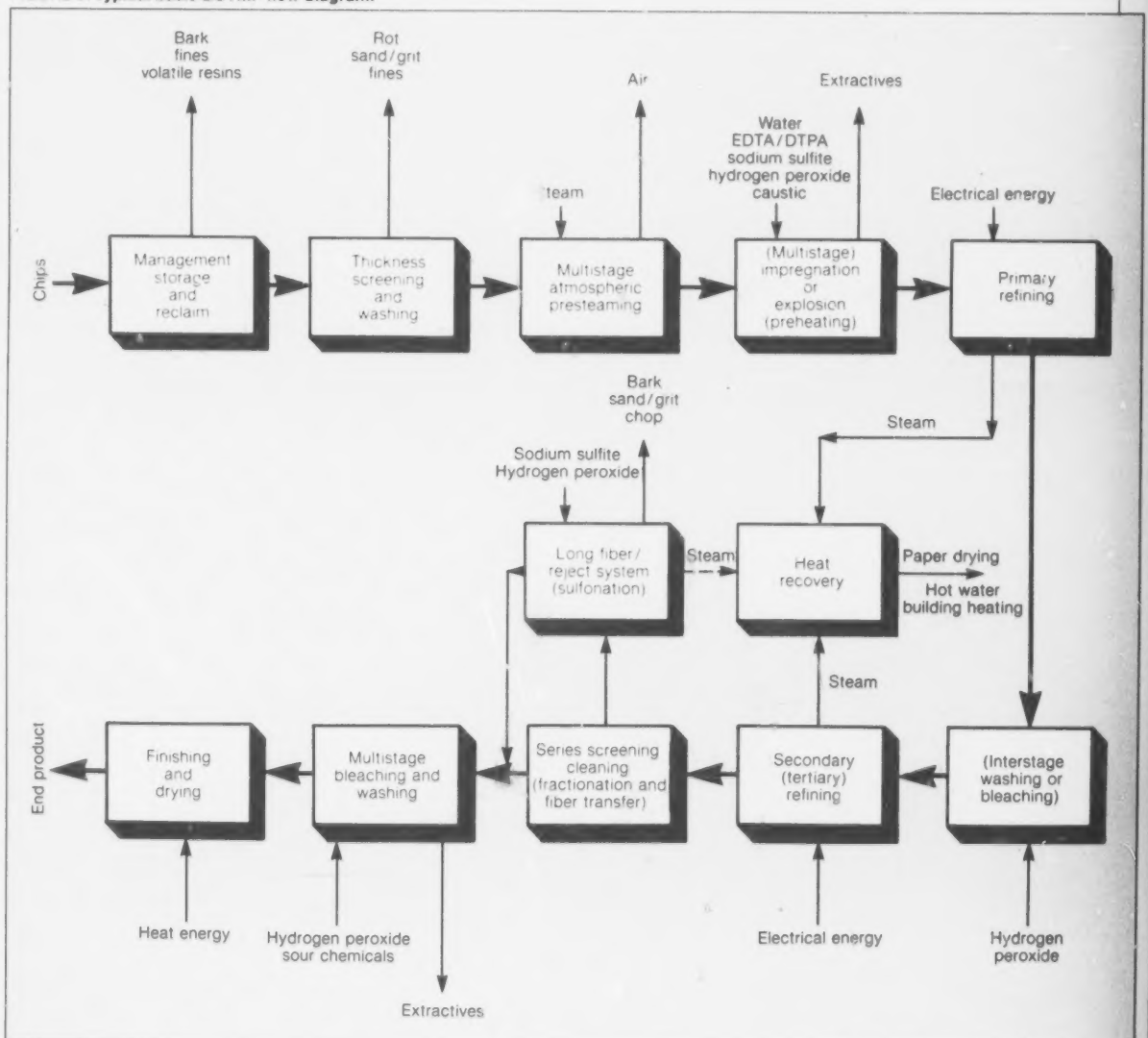
Just a few years ago, it was thought that only CMP (lower yield, higher strength) would be suitable for certain high-quality tissue grades. However, to date, almost the only end use for CMP has been for newsprint reinforcement. Current BCTMP has sufficed.

Table 16 outlines a summary of present technological advances and their results in quality improvement. Figure 5 outlines a typical basic process block flow diagram for market BCTMP.

Process effluent must be treated to comply with regional standards, which are moving quickly toward tighter restrictions on the volume and quality of effluent discharged. Treatment includes removal of suspended solids in a clarifier (primary treatment) followed by secondary treatment to remove soluble chemical compounds, such as resin acids, which consume oxygen and/or are toxic to water life when discharged.

Secondary treatment is most commonly performed in aerobic systems, in which microorganisms consume air or pure oxygen to eliminate oxidizable chemicals in the effluent. These systems include aerated stabilization basins, where treatment is for eight to ten days, or activat-

FIGURE 5: **Typical basic BCTMP flow diagram.**



ed sludge systems, which require one to two days' treatment with higher rates of oxidation. There is a trend toward use of activated sludge systems, as these permit lower solids discharge than aerated stabilization basins. Secondary treatment can also be performed in anaerobic systems, in which treatment takes place in an oxygen-deficient atmosphere and methane gas is produced for burning. Anaerobic systems normally are followed by two days of aerobic treatment to ensure toxicity removal. More precise operational control is required with anaerobic systems.

Biological treatment is the most cost-effective means of destroying oxygen-consuming waste when the concentration of this waste is less than 2,500 to 3,000 ppm of BOD_5 (biological oxygen demand), as is the case with BCTMP. Recent designs have moved toward segregating low-volume concentrated highly toxic streams (such as plug screw feeder pressates) from the plant, with a view to disposing of these by other forms of oxidation, such as wet oxidation or burning in an incinerator. Development in this area is ongoing but not yet commercially adopted. Figure 6 shows a typical BCTMP effluent treatment facility flow diagram.

In addition to advancements in market BCTMP mill technology, significant gains have been made in end-use manufacturing technology. Chemistry is a key point with regard to end uses. Alkaline papermaking has grown substantially during the past several years. It is estimated that alkaline-produced wood-free paper will approach 9 million tons in North America by 1990, representing more than 50% of total capacity. This has been driven largely by developments in onsite precipitated calcium carbonate production, which provides attractive economic and quality benefits to papermakers.

Use of alkaline paper presents a number of advantages, the key one being longevity. Alkaline-produced wood-free paper can exist with little change for more than 100 years. However, acid-sized paper will typically show degradation after 50 years.

In alkaline papermaking, calcium carbonate is used as a filler. In many cases, this is a lower-cost alternative and offers a higher brightness (close to 90%). Carbonate is particularly useful in BCTMP-containing paper. The high pigment brightness compensates for the relatively lower BCTMP brightness. The BCTMP fiber structure allows for higher carbonate loadings while maintaining bulk. This further reduces costs and also helps to minimize brightness reversion (long-term aging) to increase strength and improve runability.

ECONOMICS. Use of high levels of BCTMP in printing paper requires some changes in the papermaking process to optimize the benefits of properties and economics. Developments in high-performance, dual-component, wet-end chemical systems have made it possible to overcome the problems of slow drainage and the lower strength of BCTMP compared with chemical pulps. These same chemical systems also provide high retention, allowing increased filler loadings of 30% and higher. Without such changes in the wet-end chemicals, it becomes difficult to fully utilize the benefits of BCTMP.

Mere substitution of BCTMP for chemical pulp fibers does not, in some cases, provide sufficient incentive for the development of new grades. The real incentive comes when the bulk benefit of BCTMP is utilized to load the paper with a higher level of filler. This way the furnish costs are reduced, and printability and surface characteristics are improved.

The current economy of scale for a two-line market pulp mill is a nominal 650 to 700 air-dry tpd (or 200,000 to 240,000 tpy), depending on wood species and end product. This allows the installation to fractionate for various end products, as discussed.

The approximate capital cost in North America for a two-refiner line, 200,000-tpy greenfield mill (flash dried), is between $180 and $220 million, depending on

TABLE 16: **BCTMP technology improvements.**

Item	Result
Chip management and washing	Lower fines/bark/rot Correct size, including thickness Better deresination Lower dirt
Multi-stage presteaming impregnation	Lower extractives Lower chemical consumption Lower reversion Lower fines Higher strength Higher brightness Higher quality, uniformity
Refining	Higher quality Lower power consumption Better control/uniformity Improved plate life Increased steam recovery Higher capacity
Interstage washing or bleaching	Lower extractives Lower chemical consumption
Screening/cleaning	Proper fractionation Higher quality
Long fiber/rejects	Increased strength Lower linting Proper fiber fraction Higher quality
Dual lines (fractionating)	Better high and low CSF grades Higher qualities
Bleaching/washing	Higher brightness Lower chemical consumption Lower reversion Reduced operating cost Lower extractives
Finishing/drying	Better repulpability Lower reversion No "fish eyes"

location and wood species. This includes a woodroom, interest during construction, and working capital but not land costs. One of the highest cost components currently is environmental treatment facilities. Capital should not be reduced if this will sacrifice quality or flexibility.

Operating costs are, of course, dependent on end product, wood species, mill location, labor, transport, and financing return. However, more than 70% of operating expenses are attributed to wood, power, and chemical costs.

Table 17 provides an operating cost component comparison for various BCTMP-producing nations. In addition to those shown, these costs vary internally for these countries.

Table 18 shows a typical comparison of a greenfield market aspen fully bleached kraft mill and a market aspen BCTMP mill. It is unlikely, however, that a kraft mill of this relatively small size would be built now.

The driving force for the construction of new market BCTMP mills has been the comparatively high capital and operating costs of new chemical pulp mills.

By early 1989, the following phenomena had arrived at the same time:

- Advanced technology for BCTMP
- Advent of the utilization of other worldwide wood species, such as aspen, eucalyptus, and various pines
- Growth in world awareness of and interest in BCTMP over the past five years
- Availability of consistent, high-quality BCTMP in quantity

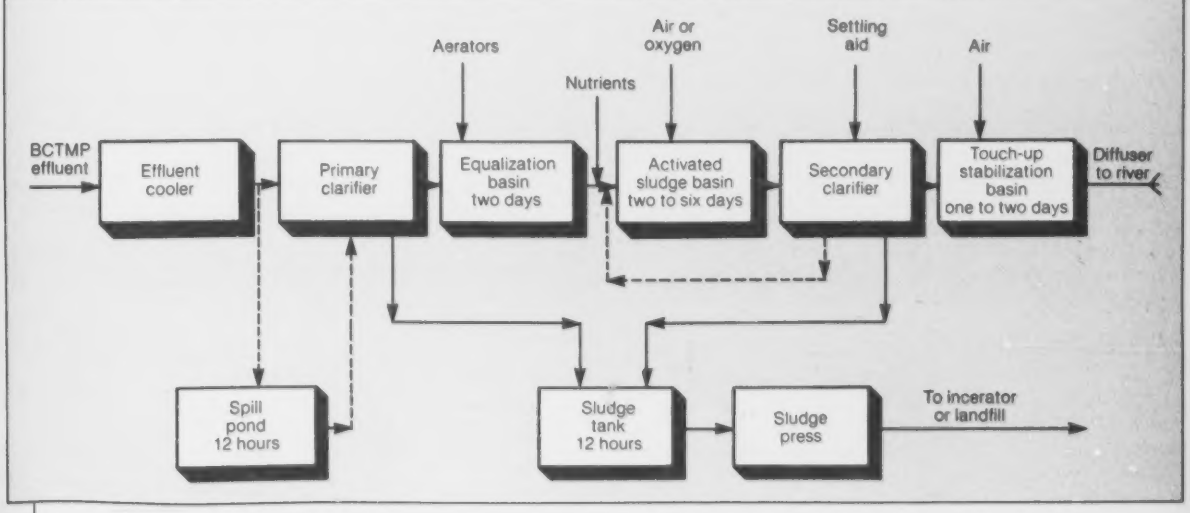
TABLE 17: **Manufacturing cost comparison of BCTMP components by region.**

Component	Sweden	Norway	Finland	Canada West (interior)	Canada Prairies (base)	Canada Quebec	Canada Maritimes	U.S. (South)	South America	Australia New Zealand
Main BCTMP species										
Softwood	Spruce	Spruce	Spruce	Spruce	Spruce	Spruce	Spruce	Southern pine	Various pines	Radiata pine
Hardwood	Aspen	Aspen	Aspen	Aspen	Aspen	Aspen	Aspen	(N/A)	Eucalyptus	Eucalyptus
Raw material										
Softwood	High	High	Highest	Low	Low	High	High	Low	Lowest	High
Hardwood	High	High	Highest	Low	Low	Low	High	N/A	Lowest	High
Electrical energy	High	Lowest	Highest	High	Low	Low	High	High	High	High
Chemicals (pulping)	Low	Low	Lowest	Low	High	Low	High	Low	Highest	High
Labor	High	High	High	Highest	High	Low	High	Low	Lowest	High

1. Costs are variable internally.
2. Electrical costs exclude any incentives.
3. Early 1989 currency rate comparison.

Source: NLK-Celpap.

FIGURE 6: **Typical effluent treatment flow diagram.**



- Acceptance of hardwood chemical pulp as a desirable furnish
- A tight market chemical pulp supply
- High-cost market chemical pulps.

Pricing for various market pulps is shown in Figure 7.

SUMMARY AND OUTLOOK. Sales techniques relating to market BCTMP require technical input from both the specifiers and the paper or pulp producers. A shortage currently exists of dedicated, technical expertise in both the manufacture and sale of BCTMP.

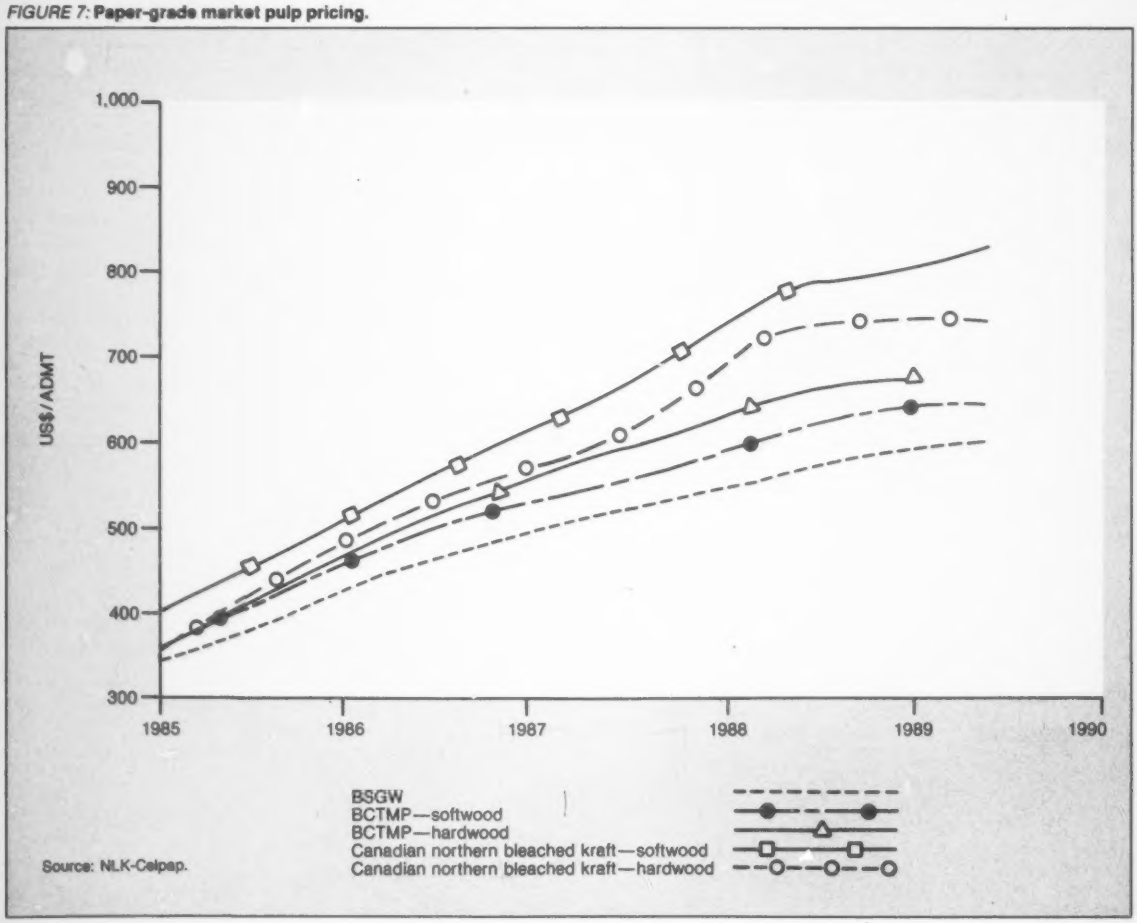
As hardwood kraft evolved from a filler to a premium pulp in the past, so time and technology will surely see market BCTMP evolve in a similar way. During the past ten years, the major gains in pulp quality and uniformity have arisen from improvements in process equipment design and arrangement. The next few years belong to chemistry. A deepening understanding of high-yield

TABLE 18: **Comparison of market hardwood kraft and BCTMP for typical western Canadian greenfield mill (750 air-dry tpd).**

Item	Unit	Aspen — 400 CSF FBK	Aspen — 400 CSF BCTMP
Yield	%	50	90
Personnel	Number	300	100
Energy (total)	kWh/a.d. ton	750	3,000
Water	m^3/t	50-60	20-25
Effluent — BOD	kg/t	20-30	60-80
Emission — air	—	Smell	Odorless
Strength properties	—	Base	Lower
Brightness, ISO	%	92	86
Opacity	—	Base	Better
Reversion	—	Base	Higher
Operating cost	US$/a.d. ton	360	300
Capital cost	US$ million	550-600	200-220
Sales price[1]	US$/a.d. ton	720	685

1. First-quarter 1989.

FIGURE 7: **Paper-grade market pulp pricing.**



pulping and bleaching chemistry, effluent treatment chemistry, and chemistry of conversion processes for high-yield-pulp-containing products (e.g., alkaline papermaking) will help to solidify the acceptance of BCTMP in high-quality products.

Other technological trends are foreseeable in the near future:

- Lower chemical consumption resulting from improved washing and mixing
- Lower energy consumption due to higher freenesses and better plate design for a given quality
- Improved quality and fiber classification due to advanced fractionation techniques
- Pulp drying utilizing all steam from refining system
- Evaporation and incineration technology
- Lower-cost environmental treatment facilities
- Online chip bulk density and moisture measurement capabilities
- Online pulp quality monitoring.

But major problems remain to be resolved:

- Color stability
- Whiteness/shade
- 90% brightness for only a few end products.

It is estimated that only about 10% of paper produced receives sufficient exposure to ultraviolet light for reversion to be a practical problem. The term "reversion" needs to be quantified, and proper measurement methods need to be determined.

Several terms will or should be eliminated from high-yield pulping terminology:

- Rejects (when included with long fiber)
- Freeness (when used as a specification for the purchase of BCTMP instead of quality)
- TMP (CTMP equipment gives higher pulp quality even when operated in the TMP mode).

Society will demand environmentally favorable paper. Nonrecyclable products, such as diapers, are an ideal end use. BCTMP will be used in increasing amounts with chemical fibers as a substitution offering certain technical and cost advantages and with waste to enhance its properties. Remember that brightness or "permanence" is not critical for all grades. Long life is not critical for all products.

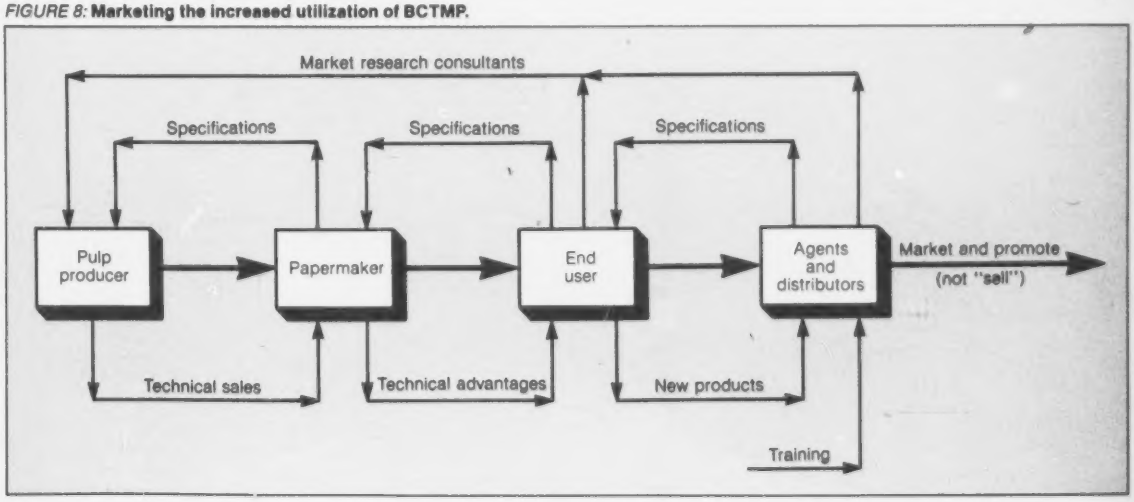
Whether to purchase or to integrate is a perplexing problem. With the present high price of kraft, BCTMP will move into more end products. Many nonintegrated mills that purchase chemical pulp are looking at backward integration. What will the driving forces be: cost only or cost, quality, and new products? The technical advantages of BCTMP will not become evident worldwide until the new-technology pulps have entered the marketplace (especially the printing and writing sector) and feedback is received. Many current and planned market BCTMP mills will forward integrate in the near future.

The reluctance by certain companies, agencies, and individuals toward the further utilization of BCTMP should at least be replaced with end-product trials using current-generation pulp. The lesser-quality pulps of past years marketed prior to their optimization have long since improved.

Wood-free rules will have to be redefined to allow not only the use of these new pulps but also the creation of new printing and writing paper grades. Lignin content is the only true comparison between groundwood and BCTMP.

BCTMP needs to be marketed and promoted as a tailor-made product. Even though any pulp is truly a commodity, BCTMP should not be sold as such. True knowledge or understanding of this pulp is still lacking. An approach is outlined in Figure 8. ■

FIGURE 8: **Marketing the increased utilization of BCTMP.**



INORGANIC MINERAL, CHEMICAL MARKET EXPECTED TO REMAIN STRONG IN 1989

Increased paper demand fuels consumption; precipitated calcium carbonate satellite plants affecting formulations; pricing to soften

By STEVE VAN KOUTEREN

In recent years, extender and filler minerals have played an increasingly important role in the North American paper industry. The main reasons are related to the 200% increase in pulp prices since 1986, the need for improved printing surfaces, and the robust demand for printing and writing paper. As a direct result of these events, consumption of extender and filler minerals in paper in 1988 reached a record high of 5.6 million tons valued at more than $1 billion.

Kaolin, which accounts for more than 75% of the total mineral demand (on a tonnage basis) in printing and writing paper, is the dominant mineral used by the paper industry (Figure 1). Second to kaolin is calcium carbonate, followed by titanium dioxide (TiO_2). Other extender and filler minerals used in paper are alumina hydrate, diatomite, precipitated silica and silicates, and silica gel.

Extender and filler material use in printing and writing paper represents more than 90% of total volume on a tonnage basis. The balance is used in coated paperboard and cigarette paper. Within the printing and writing paper segment, coated paper uses approximately 60% of extender and filler minerals, with uncoated paper accounting for the balance (Figure 2).

Strong extender and filler material demand during the past three years has tightened supply, firmed prices, and strongly increased suppliers' profits. As a consequence, nearly every major supplier has invested in new capacity; thus, extender and filler mineral supply should ease in the next few years.

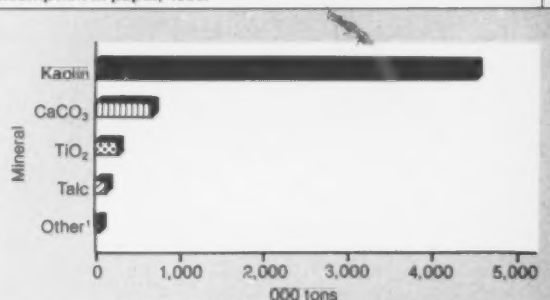
NEW KAOLIN CAPACITY. Double-digit coated paper demand growth in 1988, particularly in lightweight coated (LWC) and premium coated paper, contributed to increased kaolin demand last year. Kline & Co. estimates that demand for calcined, delaminated, and premium coating kaolin grades increased more than 5% in 1988, while air-floated and hydrous filler grades increased 3%.

Three years of strong demand for calcined, delaminated, and premium coating grades decreased availability, firmed prices, and motivated suppliers to expand capacity. Recent kaolin capacity increases by Engelhard, ECC America, Georgia Kaolin, J.M. Huber, and Thiele Kaolin amount to more than 700,000 tons of new capacity. This should ease market tightness and return some of the competitive pressure to prices seen in the mid-1980s.

CALCIUM CARBONATE FAST TRACK. The record-high pulp prices and growing market acceptance of alkaline paper have increased calcium carbonate demand by more than 15% during the past year. This increase is largely a result of growth in alkaline printing and writing paper capacity (excluding newsprint) to nearly 30% of total capacity in North America.

The proliferation of Pfizer's precipitated calcium carbonate (PCC) satellite plants has made PCC the dominant carbonate filler at the expense of ultrafine ground calcium carbonate (UFGCC). Satellite plants provide pa-

FIGURE 1: **North American extender and filler mineral consumption in paper, 1988.**



1. Includes alumina hydrate, diatomite, precipitated silica and silicates, and silica gel.

Source: Kline & Co., "Extender and Filler Minerals North America—1988."

Mr. Van Kouteren is a consultant with Kline & Co., Fairfield, N.J.

per mills with transportation cost savings and customized filler specifications as well as a guaranteed supply source.

Although PCC is the dominant carbonate filler, UFGCC still dominates the carbonate coating market. Recently, however, PCC also has begun to encroach on this segment. Advances in PCC particle shape and distribution have enabled it to partially displace UFGCC in coated paper.

On the supply side, PCC capacity continues to grow. Currently, ten PCC satellite plants are operating, and at least five more new PCC plants will begin production this year. Kline & Co. expects that by the end of 1989, total PCC satellite capacity will be more than 600,000 tpy (Figure 3). At year-end, Pfizer will have at least 11 operating plants. Steel Brothers, Champion, Olin, and Finch Pruyn each operate one satellite plant.

Despite recent acquisitions in the UFGCC industry, excess capacity exists. During the past year, Omya (Pluess-Staufer) acquired Steep Rock/Ontario Carbonates, and Georgia Marble was put up for sale. Omya recently shut down the Ontario Carbonates UF operation and probably will expand its Vermont facility.

Contrary to recently announced UFGCC price increases, discounts are still occurring in the paper market. Price discounts reflect the current oversupply situation of the UFGCC business. PCC prices are reported to be

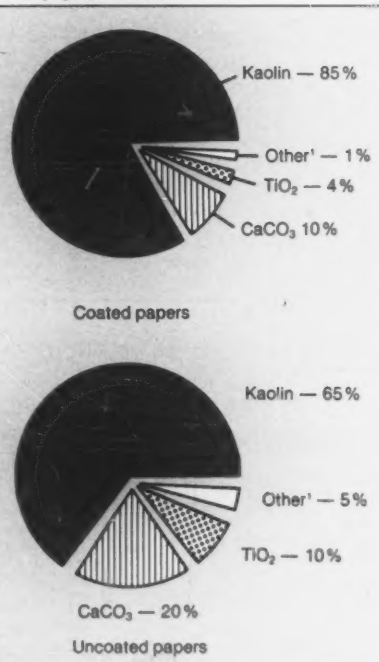
TiO_2 PRICES ON THE RISE. The TiO_2 market remains tight, and prices will continue to increase. Despite efforts to extend TiO_2, the push for whiter and more opaque LWC and uncoated printing and writing paper kept demand for this mineral at a steady 4% growth rate during 1988. Calcined kaolin, precipitated silicates, and PCC have had the biggest impact on TiO_2. Some companies report more than 50% of their previous TiO_2 requirements being satisfied with extenders in some uncoated business paper. However, TiO_2's opacity is far superior than other minerals, and, where opacity is crucial, less than 15% of TiO_2 is displaced.

Recent debottlenecking efforts at U.S. TiO_2 facilities have provided about 60,000 tpy of additional capacity but supply is still tight. Supply should begin to ease in 1990 when Du Pont, Kemira, and SCM bring online a total of about 180,000 tpy of new domestic capacity.

Demand is expected to outpace capacity expansions; therefore, price increases are expected to continue until the early 1990s. Another price increase, to approximately $1/lb effective Apr. 1, was announced in at the end of March.

OUTLOOK. Overall, Kline & Co. expects extender and filler demand growth in paper to continue, but at a slower pace for the next five years due to slower growth in the U.S. economy. During the same period, much of the planned TiO_2 and kaolin capacity will come online. Slower growth, combined with increased supply, will likely result in a softening of extender and filler mineral

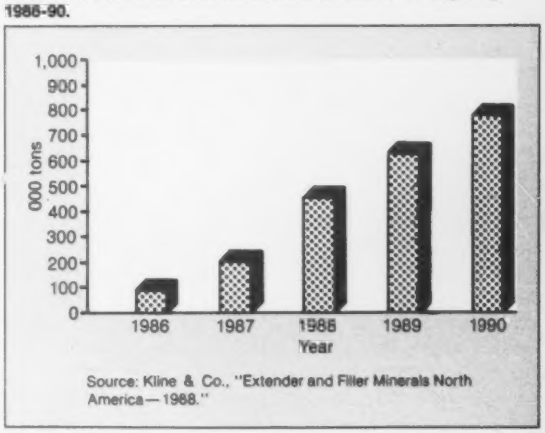
FIGURE 2: **North American extender and filler mineral consumption in paper, 1983-93.**



1. Includes alumina hydrate, diatomite, precipitated silica and silicates, and silica gel.

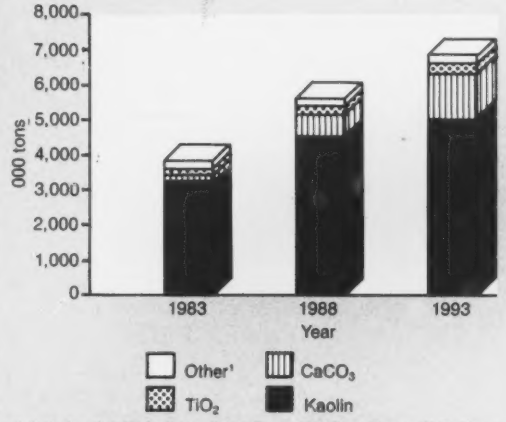
Source: Kline & Co., "Extender and Filler Minerals North America—1988."

FIGURE 3: **Estimated North American satellite PCC capacity, 1986-90.**



Source: Kline & Co., "Extender and Filler Minerals North America—1988."

FIGURE 4: **North American extender and filler mineral use in printing and writing paper by type, 1988.**



1. Includes alumina hydrate, diatomite, precipitated silica and silicates, silica gel, and talc.

Source: Kline & Co., "Extender and Filler Minerals North America—1988."

prices.

Kaolin demand will slow due to substitution of calcium carbonate for kaolin in the paper filler market and softening TiO_2 prices (Figure 4). Recent capacity expansions, along with slower demand growth, will also cause kaolin prices to soften in 1990. Prices may soften even more if kaolin deposits currently being developed in Canada are successful in producing a quality paper grade.

In contrast to the kaolin market, calcium carbonate will maintain double-digit growth as the percentage of alkaline paper capacity continues to grow. By 1992, more than 45% of all printing and writing paper, excluding newsprint, will be produced in an alkaline environment. As a result of the strong growth, future price increases or fewer discounts can be expected for most grades of calcium carbonate.

TiO_2 demand will grow at only about 2% to 3% during the next few years. Slower growth, along with worldwide increases in capacity, will result in a slight oversupply, causing prices to soften.

In summary, paper companies can expect to see an increase in extender and filler mineral availability during the next five years. Price discounts for kaolin and possibly for TiO_2 should follow the increase in supply. ■

Pure Quality.
At Colloids pure quality is our standard. And we have been producing quality products for the paper industry for over half a century. Our expanded product line includes dispersants, defoamers, surfactants, binders, retention aids, strength aids and sizes. Our commitment remains pure quality.
COLLOIDS, INC.
Paper Division
Charlotte, NC
(704) 529-6380
International
(404) 422-1250
Newark, NJ
(201) 926-6100
Marietta, GA
(404) 422-1250
St. Catharines, Ontario
(416) 688-6470

On Reader Service Card **Circle 177**

U.S. LINER MARKET SHOULD REMAIN IN BALANCE WITH NO SERIOUS OVERSUPPLY

But higher capacity growth plus moderate recession may cause operating rates to dip in 1990, Unbleached Kraft Conference told

By WILL MIES, Executive News Editor

The outlook for the U.S. linerboard industry is relatively positive through late 1989, Thomas P. Clephane, managing director, Morgan Stanley & Co., told nearly 400 industry executives and customers attending *Pulp & Paper*'s Third International Unbleached Kraft Conference in Atlanta, Ga., last November. No oversupply situation should develop, even with a moderate recession in 1990, he said.

Box shipments are expected to rise 2.5% in 1989 and then flatten in 1990, with no growth in the U.S. economy. He projected U.S. linerboard exports will rise about 4% to 5% in 1989 and 1990, after declining slightly last year due to a sharp drop-off in shipments to China.

As a result, total U.S. linerboard production is expected to rise about 2.5% in 1989 and 0.6% in 1990. Adjusted mill operating rates would drop to 96.6% in 1989 and then decline to 93.7% in 1990 in a moderate recession (Table 1).

"An environment in which the operating rate reaches 93% to 94% is usually considered a seller's market, as producers generally have the power to raise prices faster than their costs escalate," Clephane noted. Some price erosion could occur in 1990, but "the absence of major capacity additions and a firm tone in the export market should prevent a price break of the dimensions the industry experienced in 1982 and 1985."

One source of concern is new U.S. linerboard capacity growth, which Clephane estimates will rise about 4%/year from 1986-89. This new capacity is mainly coming from machine rebuilds (particularly the addition of new press sections) and conversion of kraft paper machines to linerboard production. Only two new U.S. linerboard machines have been announced for the 1988-91 period (although a new clay-coated boxboard machine will initially produce some unbleached linerboard).

There has been a similar absence of new semichemical medium machines announced for the U.S., noted Peter Bogan, vice president-sales, Mead Corp. Nevertheless, capacity growth will continue at historical levels through upgrades of existing facilities. Semichemical medium capacity will grow about 2.8%/year between 1988-91, while recycled medium will increase 4.5%/year.

KRAFT PAPER REVIVAL? Plastic packaging continues to make inroads into the retail bag and sack market, but growing environmental pressure may have some effect on slowing the trend, James Doughan, senior vice president, Stone Container Corp., indicated. Last year, a bill was passed in Suffolk County, N.Y., effectively banning plastic retail T-shirt sacks, and similar legislation has been introduced in other states.

Kraft grocery sack shipments have declined from about 1.6 million tons in 1980 to under 1.2 million tons in 1987. As a result, total unbleached kraft paper shipments have declined from 3.8 million tons in 1980 to about 3.04 million tons in 1988. On the supply side, capacity has suffered a similar decline. "Since 1984, 860,000 tons of unbleached kraft paper have been converted to the manufacture of other products or shut down," Doughan noted. "So, despite a significant drop-off in demand, operating rates have remained high."

What happens in the kraft paper market could have a significant impact on linerboard capacity growth, Doughan noted. In 1987, swing machines made 877,000 tons, or about 29% of all kraft paper manufactured, and 2.1 million tons, or about 12% of all linerboard produced.

"We hesitate to build new nonreplacement liner machines as long as the threat of decreasing kraft paper shipments hangs over our heads," Doughan said. "On the other hand, the environmental attack on plastic packaging could lead to a revitalization of the kraft paper market."

NEW HIGH-STRENGTH GRADES. The containerboard industry has begun to introduce "high-strength" grades to combat escalating box prices and improve quality and consistency of performance, said Robert Kramer, vice president, Nekoosa Packaging Inc.

Although a variety of confusing claims are being made, high-strength grades should provide substantially more compression strength per pound of fiber than con-

ventional containerboard. The standard Nekoosa Packaging has established for high-compression containerboard is an average performance level of 2 lb of ring crush/lb of basis weight. In other words, a high-compression 42-lb linerboard has to demonstrate at least 84 lb of ring crush on average.

"Today there is still considerable variation in ring crush performance within the industry," Kramer noted. He presented a graph indicating that average industry ring crush for 42-lb linerboard has been improving during the past several years but still ranged anywhere between about 60 and 95 lb in 1987. "Our industry is increasingly recognizing the importance of ring crush as it relates to finished box compression and is taking steps to improve it." But considerable variation still exists, and this affects the compression strength of the finished box, Kramer said.

IMPROVING GRAPHIC QUALITY. Manufacturers of consumer goods are increasingly interested in using packaging design and graphics as a means of influencing the purchasing decisions at the retail level, noted Frederick V. Ernst, president of Chesapeake Corp.'s West Point, Va., operations.

As a result, interest is growing in white linerboard grades, which offer various trade-offs in print quality, box performance, and cost. About 1.06 million tons of mottled white linerboard and 130,000 tons of uncoated bleached linerboard were consumed in the U.S. in 1987. In addition, an estimated 40,000 tons of coated bleached and unbleached linerboard are being used for preprinting. Another alternative is litho laminating, which offers the highest print quality but is the most expensive alternative (Table 2).

Altogether, the U.S. market for white grades is about 1.25 million tons, which means that about 15% of the boxes made in this country have some form of white on their exterior facing, Ernst estimated. "Within the white linerboard market, there is clearly going to be some reshuffling as high-quality grades are used increasingly in preprinted and direct-printed boxes."

On its new No. 3 machine, Chesapeake is producing an upgraded mottled white board and is developing a white-top grade. These new grades should offer competitive advantages over the existing white linerboard grades, Ernst indicated.

ADVANTAGES OF MULTI-PLY FORMING. How Willamette Inc. decided to completely shift over its linerboard production to multi-ply forming and the resulting improvements in sheet quality were described by Steven R. Rogel, executive vice president. The company has rebuilt two machines at its Albany, Ore., mill to make multi-ply linerboard. And last year, it rebuilt the machine at its Campti, La., mill to make a three-ply board.

"The box user is demanding higher and assured levels of quality, greatly reduced variability, and quicker delivery of small quantities," according to James Stevenson, president of SAS International said. "The importance of uniformity of moisture, porosity, color, printing surface, and receptivity to adhesives continues to grow." His remarks summed up a panel discussion on changing roll stock quality, which included William McGrattan, manager-technical services, Domtar Packaging; Richard Van Horne, president, Corrugated Supplies Corp. (Chicago); Steve S. Applegate, purchasing manager, Procter & Gamble Co.; and Joao Martins, president, Unor (a Portuguese box converter).

EUROPEAN LINER GETTING WHITER. Corrugated case consumption in Western Europe has shown 4% to 5% annual growth the last several years, according to Alain Soulas, president, Cellulose du Pin. But the average since 1980 has been about 3.1%, and this will probably be close to the trend in the future.

Helping corrugated box demand has been the increasing importance of supermarkets and hypermarkets in retail distribution. As a result, packaging has an in-

TABLE 1: **U.S. linerboard industry supply and demand forecast, 1988-90 (000 short tons).**

	1988	1989e	1990e
Production	17,996	18,500	18,700
% change	1.8	2.8	1.1
Exports	2,282	2,400	2,500
% change	−0.6	5.2	4.2
Production for U.S.	15,716	16,100	16,200
% change	2.1	2.5	0.6
Inventory change	−8	0	100
U.S. consumption	15,722	16,100	16,100
% change	3.9	2.4	0.0
Box shipments			
% change	3.2	2.5	0.0
Real GNP			
% change	3.8	3.0	0.5
FRB[1] production index			
% change	5.7	3.7	−0.5
Capacity (API)[2]	18,613	19,084	19,796
% change	3.7	2.5	3.7
Operating rate[1]	96.7	96.9	94.5
Adjusted capacity[3]	—	19,159	19,951
% change	—	2.9	4.1
Operating rate[3]	—	98.6	93.7

1. Federal Reserve Board.
2. Based on American Paper Institute's December 1988 survey.
3. Swing capacity shift from kraft paper to linerboard increased effective linerboard capacity by about 15,000 tons in 1988 and by an estimated 75,000 tons in 1989 and 80,000 tons in 1990.

Source: Morgan Stanley Research estimates (updated slightly from original presentation).

TABLE 2: **Estimated U.S. white linerboard market.**

	Tons (000)	Annual growth
Mottled white	1,060[1]	7.7%
Uncoated bleached	130[1]	4.4%
Coated (total)	40e	—
Litho laminate	—	—
	1,230	

1. American Paper Institute 1987.

creased role in promoting products. Food products, which account for about half of corrugated use, have been showing particularly strong growth.

Growth in European containerboard consumption has been somewhat slower, increasing at a 2.2%/year rate since 1980 to about 11.4 million tons in 1987. However, unbleached kraft linerboard shipments to Europe have been growing only at about a 0.5%/year rate, including an expected 3% rise in 1988. The slower growth for kraft liner reflects the increased market share being captured by wastepaper-based liner.

Soulas said he expected wastepaper-based liner to continue to increase market share in Europe in coming years but at a slower rate since the fast-growing food packaging market uses more kraft liner. Unbleached kraft liner shipments to Europe will probably grow at about a 1%/year rate in the future, he said. Meanwhile, European unbleached linerboard capacity over the next several years will be rising at about a 3.5%/year rate.

The market share for white liner grades in Western Europe increased from 11% in 1981 to 16% in 1987, according to Mattias Wigardt, marketing manager and director at ASSI Kraftliner. White-top liner showed the strongest growth, increasing from 3% to 9% of the total kraft liner market. Mottled remained steady at just below 6%, while fully bleached lost almost half of its market share (Figure 1).

Total consumption of white kraft liner grades in Europe is currently close to 600,000 metric tons, while another 250,000 tons of white testliner is also consumed, Wigardt estimated. The reason for the strong growth in white-top liner again has been the growing distribution of consumer goods and produce through large, self-service retail outlets, where the visual appeal of packaging is important.

The growing demand for white-top linerboard is also related to the spread of preprint technology, Wigart noted. At least 25 four- to six-color printing presses are now installed in Europe, and demand for decorative cases may increase by 10%/year in the most advanced European markets, according to one estimate. Traditional methods for postprinting boxes have been improving and showing 5% to 6%/year growth.

TABLE 3: **Growth of testliner capacity in three Asian countries, 1980-90 (000 metric tons).**

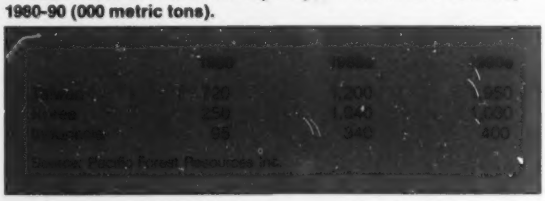
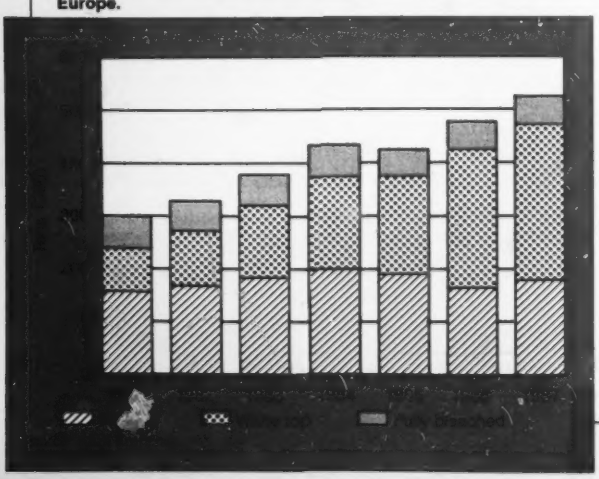


FIGURE 1: **Consumption of white kraft liner grades in Western Europe.**



BETTER MARKET BALANCE IN JAPAN. Japan is the second-largest linerboard market after the U.S. but is also known as one of the most complicated and demanding in the world, according to Michael McCann, vice president, DaiEi Papers USA Corp. "This is due to a combination of higher consumer packaging requirements and a generally weak supply/demand ratio for a number of years causing intense competition."

Not much pure kraft linerboard is consumed in Japan, and the two most common grades are K' and K", which contain varying percentages of wastepaper, while C-liner is based mainly on wastepaper.

The Japanese containerboard industry has suffered from serious overcapacity, although actual operating rates are difficult to estimate because many machines produce a variety of grades (e.g., core board, chipboard, etc.). Under guidelines from the Ministry of International Trade & Industry (MITI), capacity has been reduced by 8% since 1980, while demand has increased 5% to 6%/year. "With no new capacity planned, it is estimated supply and demand will be balanced within the next two years," McCann said.

CHINA MODERNIZATION DRIVE. Since 1980, People's Rep. China's economy has seen rapid growth under its "reform and open door" policy. Exports have enjoyed strong growth, and this has led to increased demand for improved packaging, which meets international standards, said Chen Haiqing, deputy general manager, Import Dept., ChinaPack Inc.

In 1987, People's Rep. China's production of paper and board totaled 11.4 million metric tons, of which 6.6 million tons were paper and 4.8 million tons were paperboard (including 770,000 tons of kraft linerboard).

Due to its large population, growing exports and limited forest resources, People's Rep. China has to import substantial quantities of pulp, paper, and paperboard. In 1987, People's Rep. China imported 1.26 million tons of paper and board (including 490,000 tons of kraft linerboard and 180,000 tons of corrugating medium).

Under its modernization program, People's Rep. China has been making substantial progress in upgrading its domestic containerboard industry, Haiqing said. Rapid

progress has also occurred in box production. About 250 plants, with about 80 corrugated lines, specialize in production of boxes for export packaging.

TESTLINER BULGE IN PACIFIC RIM. Despite the dramatic growth in U.S. exports to the region, it is not safe to assume that kraft linerboard is growing in popularity in the Far East, according to William A. Gleason, president of Pacific Forest Resources Inc. In fact, U.S. kraft linerboard share of the market in seven Asian countries (Hong Kong, Indonesia, Rep. Korea, Malaysia, the Philippines, Singapore, and Taiwan) has declined from 20% in 1980 to 16% last year, he estimated.

"The fact is that imported kraft linerboard plays a very limited role in domestic packaging within the region," Gleason noted.

Imports of kraft linerboard into the region will not grow significantly in the foreseeable future, even though duties and taxes in some countries have been reduced. This is because a phenomenal growth in testliner capacity is under way in such countries as Taiwan, Rep. Korea, and Indonesia. These three countries will be capable of producing 40%, or 700,000, more tons of testliner in 1988 than in 1987 and 65%, or 1.54 million, more tons in 1990 than in 1988 (Table 3).

WHO HAS THE LOWEST COSTS? U.S. linerboard mills currently enjoy a significant cost advantage over competitors in Scandinavia, thanks to the 1986-88 decline in the value of the U.S. dollar, but could face future competition from Pacific Rim countries with low wood costs, according to Fred D. Iannazzi, president of Andover International Associates. He estimated that the delivered cost in northern Europe for a southern U.S. linerboard mill was about $310/metric ton, compared with $360/ton for a mill in Sweden. However, he estimated the delivered cost for a mill in Brazil or Chile at around $220/metric ton. "Significant competition in kraft linerboard from nontraditional sources is not imminent but likely during the mid-1990s," he said.

WHY NO GREENFIELD MILLS. The economic design capacity for a state-of-the-art linerboard mill today is about 1,870 tpd—a figure largely determined by the size of new chemical recovery boilers, noted Nickey Rudd, vice president, BE&K Engineering. But few companies today have such "mega-projects" under study because of site location, financing, and marketing problems related to introducing such a large amount of capacity.

Rather, the industry is achieving substantial incremental capacity growth through modernization and expansion of existing mills. Such rebuild projects may add as much as 700 tpd and are usually designed to improve sheet quality and reduce manufacturing costs.

Major components of such projects may include new headboxes (some with multi-ply design), top-wire forming units, and a major press rebuild (either a 2,000-pli large-diameter roll press or a 6,000-pli shoe press). Fiber supply may be increased either by adding recycled fiber processing capability or by optimizing an existing kraft pulp mill. The cost of such rebuilds typically ranges from $45 to $60 million, resulting in average cost/daily ton of incremental capacity of $150,000 to $200,000.

"With currently identified projects, more than one-fourth of the existing linerboard machines will be equipped with modern forming sections and high-intensity press sections by the end of 1989," Rudd predicted. He added that up to half of the existing machines may have undergone such rebuilds by the end of 1990. Another alternative source of future industry capacity will come from the construction of smaller "mini-mills" based on recycled fiber near major metropolitan areas. Capital cost per daily ton for a recycled mill is about $150,000 to 250,000, compared with $300,000 to 400,000 for a greenfield kraft linerboard mill, according to Richard A. Reese, OPTEC technical manager at Rust International (see article on p. 153).

Financing alternatives for new projects and acquisitions in today's capital markets were described by Robert R. Morse, vice president, Salomon Brothers Inc. Due to depressed equity prices, paper companies have been going to public markets for debt financing in recent years.

Another alternative to public markets is private placements, which allow more customized financing. One example is project finance, which allows a project sponsor to borrow on a nonrecourse basis if project economics can support the leverage. Such financing is now being used for improving existing facilities (Stone Savannah River Pulp & Paper).

COATED KRAFT EXPANSION BOOM. U.S. capacity for natural kraft board (NKB) is expected to jump by almost 60% to more than 1.5 million tons by 1993, according to Coleman Rowland of Lakeway Research, an Austin, Texas-based consulting firm. Most of this tonnage will come from Mead's new 360,000-tpy machine at Mahrt, Ala., which is scheduled to start up in 1993.

Because of quality and cost advantages, NKB is expected to increase its share of the domestic boxboard market over the next five years. NKB is expected to grow 9%/year, solid bleached sulfate (SBS) shipments are to increase at less than 1%/year, and recycled boxboard may decline by some 3%/year. ■

Session chairmen for the Third International Unbleached Kraft Conference were Conrad Schweitzer, executive vice president, Georgia-Pacific Corp.; Michael R. Harwood, general manager-Containerboard Div., International Paper Co.; Michael Schaefer, vice president-containerboard marketing, Weyerhaeuser Paper Co.; and William H. Swisshelm, senior vice president and general manager, Packaging Corp. of America.

Pulp & Paper's Fourth International Unbleached Kraft Conference is scheduled for November 1990 in Chicago, Ill.

OCC CONSUMPTION EXPECTED TO GROW AS COST OF VIRGIN FIBER INCREASES

New technology, equipment can reduce OCC quality variations while new opportunities for building recycled mills increase

By RICHARD A. REESE

Recovery and consumption of recycled corrugated containers is growing at a rapid rate. Table 1 shows changes in consumption that have occurred since 1977. Growth in domestic consumption averaged 1.8% from 1977 to 1982 and 7.5% from 1982 to 1987. Most of the change in consumption has been increased use of old corrugated containers (OCC) in kraft linerboard and semichemical corrugating medium. OCC now comprises about 10% of kraft linerboard and 30% of semichemical medium furnishes. Recycled fiber is the "fortifying fiber" on most semichemical medium machines.

Export tonnage has grown at an even faster rate. The average annual change in export tonnage was 10% between 1977 and 1982 and 23.3% between 1982 and 1987. Collections grew by 2.5%/year between 1977 and 1982 and 9.3%/year between 1982 and 1987. Collections were 40.2% of domestic consumption in 1977, 44.3% in 1982, and 48.8% in 1987. The practical limit for OCC recovery is now likely between 60% and 70%.

ECONOMICS OF OCC CONSUMPTION. Table 2 shows corrugated waste consumption by region. The large consumption in the East north central, Mountain, and Pacific regions is primarily by mills using 100% recycled fiber. The high consumption in the South Atlantic region is mostly by kraft linerboard and semichemical corrugating medium mills. It is obvious that some areas, such as New England, where OCC is available but consumption is low, could be locations for recycled mills.

Figure 1 shows year-end OCC prices in different areas since 1980. The same trends have occurred in all regions. In 1985, relative prices increased significantly on the West Coast due to high demand for export. This change has made it attractive for West Coast consumers to buy OCC from as far away as Chicago, Ill. Figure 2 shows linerboard production for domestic use between 1940 and 1987. Recycled linerboard was 40% of total production in 1940 vs 3% in 1987. Recycled linerboard tonnage fell from 800,000 tons in 1940 to 475,000 tons in 1987. Figure 3 shows corrugating medium production for the same period. This grade was 32% of domestic production in 1940 and 23% in 1987. Corresponding recycled corrugating medium tonnages were 290,000 in 1940 and 1.64 million in 1987.

RECYCLED VS VIRGIN PULP MILLS. Recycled containerboard mills can be competitive with kraft mills as long as OCC prices are reasonable. Two of the largest recycled linerboard mills have cogeneration systems that improve their economic positions.

Capital cost per daily ton is lower for a recycled mill than for a comparable mill using virgin pulp. Cost ranges are from $150,000 to $250,000 for a recycled mill and from $300,000 to $400,000 for a greenfield mill.

Why isn't everyone building recycled containerboard capacity? Containerboard prices have not been high enough until recently to justify new greenfield capacity.

Mr. Reese is OPTEC technical manager, Rust International Corp., Birmingham, Ala. This article is based on a paper presented at the Third International Unbleached Kraft Conference held in Atlanta, Ga., in November 1988.

TABLE 1: **Recycled corrugated consumption in short tons (000).**

TABLE 2: **Corrugated waste consumption by region--1987.**

FIGURE 1: **Old corrugated prices.**

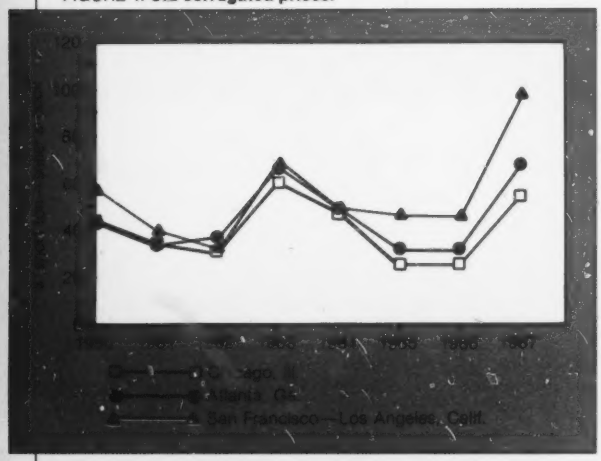


FIGURE 2: **U.S. linerboard production, 1940 to 1987.**

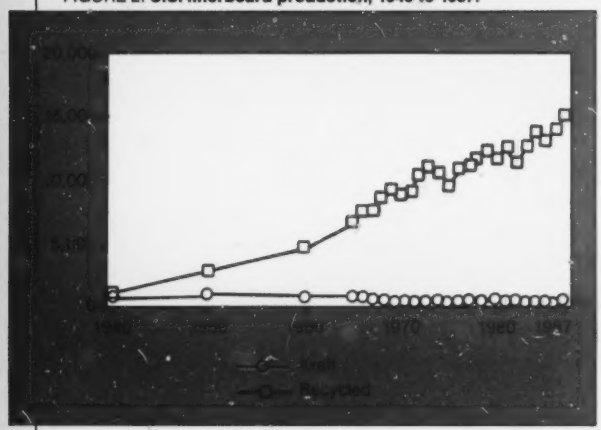
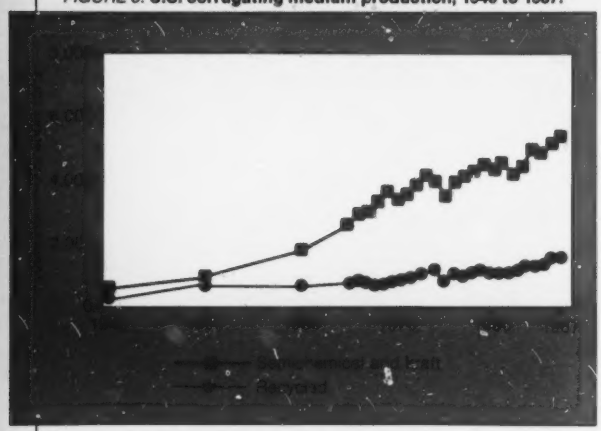


FIGURE 3: **U.S. corrugating medium production, 1940 to 1987.**



The only new greenfield capacity for containerboard in the last ten years has been at International Paper Co., Mansfield, La., and the Inland Container Corp. 100% recycled mill at Ontario, Calif.

New papermaking technology in the forming and pressing areas has made paper machine rebuilds attractive. The high cost of capital equipment encourages optimization and upgrade of existing facilities. Fiber used in many kraft linerboard and semichemical corrugating medium expansions has been recycled fiber.

QUALITY DIFFERENCES. Compared with virgin kraft containerboard, recycled containerboard has inherently lower strength, appearance, and printability/surface characteristics. The differences have greater significance on linerboard than on corrugating medium. Since the latter is sandwiched between linerboard sheets, appearance and printability differences are not really important. Accordingly, recycled corrugating medium has had a much greater acceptance in box plants.

Strength differences can be compensated by wet end additives and/or running a size press. In fact, some recycled mills achieve better compression strength than mills using virgin fiber. Recycled linerboard has a "dull" look rather than the "sheen" look of kraft linerboard. Most recycled mills add dye to the wet end or size press to match the color of kraft linerboard sheets.

Recycled sheets generally do not look as clean as virgin kraft sheets and are characterized by spots of different sizes, color, and shape, depending on the effectiveness of the stock preparation cleaning and screening systems. Some box plants prefer to use recycled linerboard on the inside of corrugated boxes, where sheet appearance is less obvious to users.

Printing ink soaks into recycled linerboard sheets more than into kraft sheets. This leaves printing voids on the surface, which can be objectionable depending on box application. Some manufacturers feel that the greater penetration is related to more short fibers on the surface. Smoothness can also affect print quality.

The presence of stickies in the sheet can cause separate layers of paper in rolls to stick together, in addition to causing appearance problems. Contaminants can restrict calendering as web consolidation tends to flatten the stickies and make them cover a larger area.

The presence of wax and other slippery materials can result in a lower coefficient of friction in finished sheets. This can cause slippage of boxes from stacks and other problems. Some mills apply a silica antiskid material that can cause problems in corrugating plants by coming off on printing plates and reducing cutter blade life. One mill reported a coefficient of friction of 16 to 18 without an antiskid material and 25 to 27 with its application. Effective removal of waxes and other slippery materials can eliminate the need to apply antiskid materials. Some U.S. mills spray silica solution on the web at the dry end of the paper machine.

Recycled containerboard often runs differently on corrugators than do virgin sheets. Corrugating plant operators must adjust operating conditions to achieve good performance. For example, test liner can warp, so more heat must be applied to dry the web. Test liner also will not stand as much abuse on the pressure roll as kraft linerboard. Pressure roll loadings that are 20% to 25% lower must be used when running test liner.

SECONDARY FIBER SYSTEMS. The key to successful production of test liner is delivery of good-quality recycled fiber to the paper machine. Recycled fiber contains several different types of contaminants that must be removed to avoid paper appearance problems. Technology exists to remove virtually all contaminants from recycled fiber. No existing 100% recycled mills have state-of-the-art secondary fiber systems. The challenge is to install and operate a cost-effective system that will provide satisfactory fiber quality.

The major raw material used in recycled containerboard is OCC. Types and levels of contaminants vary depending on the source and end use of OCC. For example, moving boxes are relatively clean and free of contaminants, while boxes used for fruit and produce often have heavy wax treatment to provide a water barrier. Contaminants can include the following:

- Heavyweight materials—metal, grit, wire, sand, ceramics, and rocks
- Lightweight materials—plastics, polystyrene foam, wax, hotmelt
- Adhesives and latex-based stickies
- Other materials—asphalt, shives, chop, bark, and ink.

Average yield of good fiber is 85% on an oven-dry basis. OCC in the U.S. is normally about one-third corrugating medium and two-thirds kraft linerboard. Strength is somewhat lower than kraft pulp since corrugating medium is produced from semichemical hardwood pulp.

European OCC has lower strength and different contaminants than OCC in the U.S. The lower strength is related to the fact that European OCC normally has been recycled four to five times. European OCC generally has less waxes and hotmelts than OCC in North America but higher gross contaminant levels due to plastic bags and other materials. Asphalt is used as a moisture barrier. European mills also use some other grades of wastepaper in test liner, including wastepaper that is both bleached and unbleached, and chemical and mechanical fibers.

Nearly all stock preparation systems include the following:

- Pulpers to break up the bales of waste fiber and put paper fibers and contaminants in a water slurry
- Baggers and junk towers on the pulpers to collect wire, staples, rags, stones, and other large contaminants
- High-density cleaners to assist in the removal of heavyweight contaminants
- Coarse screens (0.078-in. holes) to assist in the removal of relatively large contaminants
- Fine screens (0.014-in. slots) to remove smaller contaminants
- Secondary and tertiary equipment to treat rejects removed from the primary fiber line
- Thickeners to increase stock consistency for storage.

STATE-OF-THE-ART FOR U.S. OCC. A schematic of a basic state-of-the-art secondary fiber system is shown in Figure 4. The system shown is a "removal system" in which each unit operation is accomplished at optimum consistency for efficient removal of contaminants. The system shown in Figure 4 does not include fractionation by fiber length or dispersion. The following are major components and their primary functions:

- Material handling—delivers recycled fiber bales to pulper
- Pulper—separates individual fibers by water dilution and agitation and removes large contaminants, such as wires, staples, rocks, and soda cans
- Pulper detrasher—removes large lightweight contaminants and returns good fiber to pulper
- High-density cleaners—remove smaller heavyweight contaminants, such as stones, short pieces of wire, and coarse grit
- Coarse hole screens—remove relatively large light and heavyweight contaminants
- Medium-density cleaners—remove finer heavyweight contaminants, such as sand and grit
- Fine-slotted screens—remove smaller-scale materials, primarily lightweights
- Through-flow cleaners—remove most lightweight contaminants not removed previously, such as waxes
- Dewatering unit—thickens stock to approximately 12% consistency for efficient storage
- High-density storage—surge capacity between stock preparation system and paper machine
- Reject handling—equipment to remove water from rejected material to minimize landfill hauling costs
- Clarification system—system to remove some contaminants from water to permit recirculation.

KEY GUIDELINES. Proper consistencies for efficient contaminant removal in each operation are as follows:

- Pulper—4% to 5%
- High-density cleaning and coarse screening—3% to 3.5%
- Medium-density cleaning and fine screening—1.5% to 1.8%
- Through-flow cleaners—1%

Recommended barrier opening sizes are as follows:

- Pulper extraction plate—0.5 to 0.7 in.
- Pulper detrashing unit—0.25 to 0.50 in.
- Coarse screens—0.055- to 0.079-in. holes (bar-type cylinders)
- Fine screens—0.010- to 0.014-in. contour slots.

FIGURE 4: **Recycled fiber system modules.**

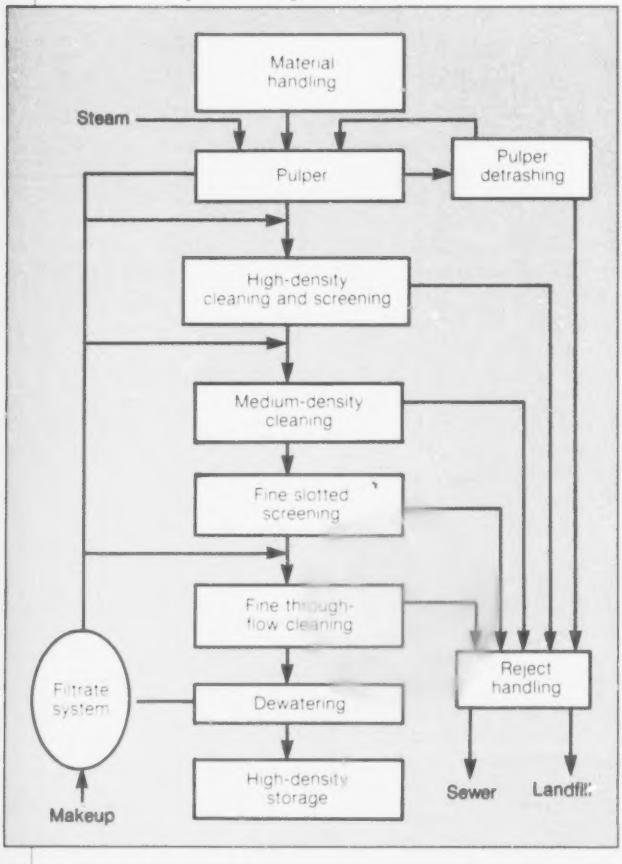
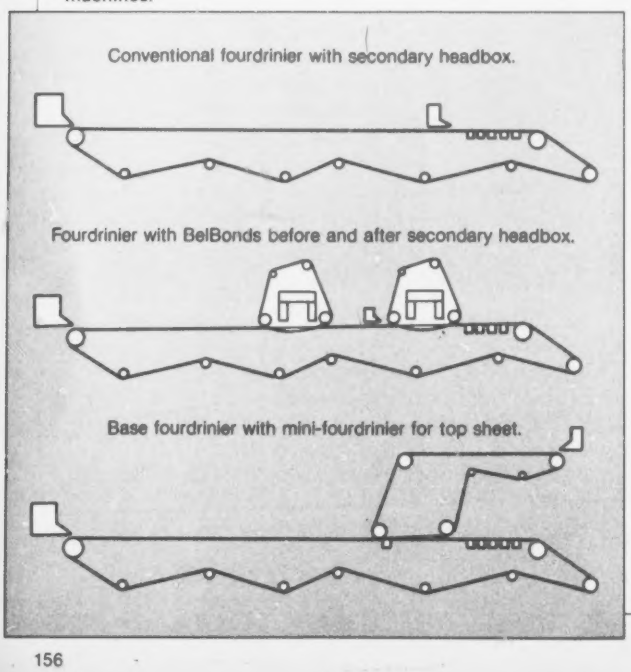


FIGURE 5: **Fourdrinier arrangements on recycled linerboard machines.**


Conventional fourdrinier with secondary headbox.
Fourdrinier with BelBonds before and after secondary headbox.
Base fourdrinier with mini-fourdrinier for top sheet.

Secondary and tertiary screens to process rejects from each stage should have the same opening sizes as primary screens. Medium-density cleaners must be installed ahead of the fine-slotted screens to achieve satisfactory basket life. Medium-density cleaners remove sand and other abrasive materials that cause rapid wear of contour fine-screen plates.

Some suppliers recommend installation of fine forward-flow cleaners ahead of the through-flow cleaners. Others feel that fine forward-flow cleaners should be installed on the paper machine. Machine cleaners would also remove contaminants that enter the system from the paper machine broke system and also from other sources.

Few mills in Europe use reverse or through-flow cleaners. Reverse and through-flow cleaners require close control of operating pressures and consistency to achieve good separation. It is likely that fewer lightweight contaminants in European OCC also contribute to the lack of through-flow cleaner application.

Secondary fiber equipment suppliers say that good test liner appearance can be achieved without a dispersion unit. However, no major test liner mills in North America are operating without dispersion systems. Some kraft linerboard mills claim to be achieving good recycled stock cleanliness with reverse or through-flow cleaners, but they are running relatively low percentages of OCC.

It is difficult to project sheet cleanliness based on laboratory trials since rejects are treated differently in laboratories than in commercial installations. However, a test liner mill is currently installing through-flow cleaners and will shut down its dispersion system.

EUROPEAN VS U.S. SYSTEMS. Most European OCC stock preparation systems are significantly different from that depicted in Figure 4. Most systems operate at consistencies of more than 3% and include fractionation and dispersion systems. High-consistency operation reduces the amount of contaminants that can be removed. Fractionation permits separation of long and short fibers for use in top- and basesheet test liner or use of short fiber on corrugating medium machines.

European systems seem to be based on taking out coarse contaminants at the pulper and detrashing units, high-density cleaning and screening, fractionation, and dispersion of long fiber fraction. These systems generally do not include removal of fine contaminants in cleaners and screens.

A basic system such as that shown in Figure 4, with provisions for stock fractionation at 3% to 3.5% consistency after fine through-flow cleaning and inclusion of a dispersion system between the dewatering unit and high-density storage, appears to have the best potential for U.S. recycled mills. Commercial experience with state-of-the-art systems will determine if dispersion systems can be eliminated.

PAPER MACHINE. Three different forming section configurations are currently used on recycled linerboard machines (Figure 5). Current machines in the U.S. use conventional fourdriniers with secondary headboxes. The fourdriniers are long to compensate for the low freeness and slow drainage rates of secondary fiber furnishes. Slow drainage rates can result in a concentration of short fibers on the top of the basesheet. Low tear and cracking/score problems can be experienced on heavyweight grades, such as 69-lb linerboard. Major U.S. test liner producers are evaluating changes to improve forming section performance.

Top-wire units with vacuum dewatering are installed on some machines in Europe running 100% recycled fiber. Performance is good, and one mill reported concerns with dewatering capacity with top-wire units.

Mini-top fourdriniers are installed on several European test liner machines. This concept includes forming top- and basesheets separately and joining them at a moisture content of about 10%. Overall sheet strength is increased by forming separate lighter-weight plies. One potential problem is low ply bond between the top- and basesheets. Some mills spray starch between the two sheets to improve ply bonding. Good ply bond can be achieved by closely monitoring moisture content of the top- and basesheets at the joining point.

There is some concern that paper machine efficiency will be lower using a top fourdrinier rather than a conventional fourdrinier or a fourdrinier with top-wire units. Some top fourdrinier machines installed in the U.S. have not performed well. Some of the problems experienced have been unique applications and lack of expertise.

A mini-top fourdrinier may be the best choice for a recycled test liner machine. The major reason is better drainage capacity by producing lighter-weight sheets and higher sheet strength. Higher strength will reduce the amount of refining necessary to achieve acceptable strength tests. A conventional fourdrinier with top-wire units would be an alternative selection.

PRESSING. A good press section can consolidate the web and increase mullen and ring crush tests. Recycled stock generally dewaters more easily in the press section than virgin kraft furnishes. Sheet dryness of 3% to 4% higher is typical at comparable press loads. Most paper machine suppliers recommend a double-felted first press followed by a long-nip or wide-nip second press. There are two basic options for good test performance on the last press nip on linerboard machines:

- Long-nip press (LNP). This is a large-diameter-roll, double-felted press with a maximum nip pressure of 2,000 pli. Nip width is 2.5 to 3.5 in.
- Wide-nip press. These presses have nip pressures of 5,500 to 6,000 pli at a nip width of approximately 10 in. The Beloit Extended Nip Press (ENP) has a ceramic shoe with a rubber blanket running between the shoe and the top roll. The Voith Flexonip has a rotating flexible cover on the bottom press roll. The Sulzer Escher Wyss Intensa S design has a concave Nipco shoe inside a flexible roll shell in the bottom position and a standard Nipco roll in the top position.

Wide-nip presses achieve sheet dryness of 3% to 4% higher than long-nip presses. Expected sheet dresses would be about 45% to 47% with an LNP and about 50% to 51% with a wide-nip press using a typical U.S. test liner furnish. The greater dewatering provided by a wide-nip press would permit installation of fewer dryers. This would partially offset the higher capital cost of these units.

SIZE PRESS. One of the key questions from a technology standpoint is whether or not a size press is necessary on a recycled linerboard machine. Most machines producing recycled linerboard have size presses, while machines producing kraft linerboard generally do not have size presses. Size presses generally increase mullen tests 3 to 5 points and enhance ring crush.

One U.S. test liner mill does run a size press. It previously ran a size press and conducted trials a few years ago with and without the size press. Its box plants could not see a difference, so the mill eliminated the size press, allowing higher machine speeds since the sheet was not rewet in the middle of the machine. The mill runs internal cationic starch, which it feels is more cost-effective than operating a size press.

All European test liner machines use size presses, operating with sheet moisture content of 10% to 20% entering the size press. High sheet moisture content improves starch penetration in the sheet, which is necessary to achieve good sheet runability and glueability on corrugators. Some European mills indicated that they could probably run without size presses if they had U.S. quality OCC.

A size press should be included on a new test liner machine installation in the U.S. Size presses enhance ring crush tests, and the growing emphasis on ring crush adds credence to inclusion of a size press.

SUPPORT SYSTEMS. Use of recycled fiber can create some special problems on paper machines. The key parameter is the effectiveness of contaminant removal in the stock preparation system. Most paper machines running recycled fiber have problems with filling on forming fabrics, press felts, and dryer fabrics. Some mills have developed procedures and special equipment to minimize the effects of contaminants on the paper machine.

Recycled fiber is more difficult to dewater on the forming section than virgin kraft. Some mills are running double- or triple-layer forming fabrics to increase dewatering capacity. Special-design press and dryer fabrics are not necessary, but designs that are easy to keep clean should be considered. ■